Appendix

WATER and RELATED LAND RESOURCES

EL RIO ARRIBA SUB-BASIN
UPPER RIO GRANDE BASIN

NEW MEXICO

NEW MEXICO STATE PARK PHOTO

PRELIMINARY
EARLY ACTION OPPORTUNITIES

A Report Based on a Cooperative Study by

THE UNITED STATES DEPARTMENT OF AGRICULTURE

and the

NEW MEXICO STATE ENGINEER

PREPARED BY

SOIL CONSERVATION SERVICE - ECONOMIC RESEARCH SERVICE - FOREST SERVICE

ALBUQUERQUE, NEW MEXICO 1969

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APPENDIX

EL RIO ARRIBA SUBBASIN PRELIMINARY REPORT

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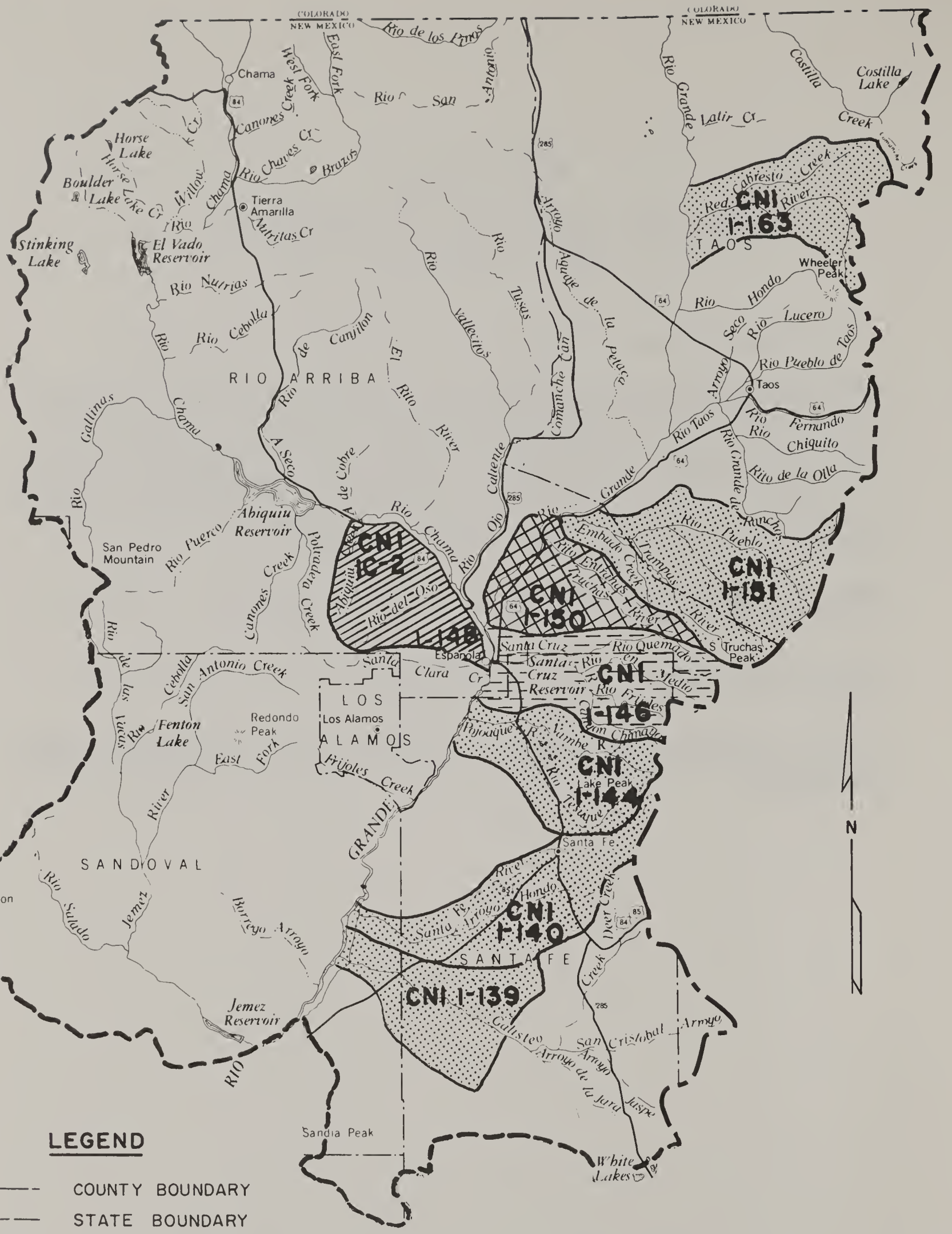
This appendix describes seven selected watersheds that have a potential for Public Law 566 type watershed projects to help solve the water and related land resource problems and needs of the basin. Watershed investigation reports are presented for five of the watersheds. A summary of the watershed work plan for the Sebastian Martin-Black Mesa Watershed is included. Information is also included for the Espanola-Rio Chama Watershed which is in the process of being planned.

These are watersheds on which it is determined a project is potentially feasible which should be initiated as soon as possible.

The following page is a map depicting these seven watersheds and one watershed upon which a project is complete.

The works of improvement outlined in each watershed investigation report can be accomplished under Public Law 87-703, Resource Conservation and Development.



LEGEND

- COUNTY BOUNDARY
- STATE BOUNDARY
- AUTHORIZED FOR PLANNING
- AUTHORIZED FOR CONSTRUCTION
- POTENTIAL
- COMPLETED

Scale

5 0 5 10 15 Miles

APPROX. SCALE 1:1,000,000

PL 566 PROJECTS

EL RIO ARRIBA SUB-BASIN- UPPER RIO GRANDE BASIN

RED RIVER WATERSHED INVESTIGATION
Upper Rio Grande Basin
Taos County, New Mexico
CNI 1-163

The Watershed in Brief

The watershed is located in northern Taos County east of the Rio Grande. Red River, a tributary of the Rio Grande, is the principal stream. Cabresto Creek, a major tributary, enters the river at Questa. The watershed has an area of about 216 square miles of which about 10 percent is privately owned, 2 percent is state land, and the remaining 88 percent is federal land, primarily National Forest.

The town of Questa, at the junction of State Highways 3 and 38, and the resort town of Red River are in the watershed. The major flood damage occurs near and in the town of Red River.

Altitudes range from about 6600 feet above mean sea level on the Rio Grande to 13,160 feet at the top of Mount Wheeler. The entire watershed is in the Southern Rocky Mountains Land Resource Area. Average annual precipitation ranges from 12 inches at Questa to about 30 inches in the mountains.

The principal land use is for grazing livestock. There are about 3,800 acres of irrigated land serviced by 8 ditch systems. The principal crops are small grains, alfalfa, and grass hay or pasture.

The vicinity of Red River is extensively and intensively used for recreation. All of summer and winter recreation activities are available. The two most popular activities are fishing and skiing.

Between Questa and Red River the Molybdenum Corporation of America operates molybdenum mines and a reduction plant.

The entire watershed is in the Northern Rio Grande Resource Conservation and Development Project area. Several project measures have been completed to improve agricultural water management. The watershed is also within the Four-Corners Economic Development Region.

Watershed Problems and Needs

Damaging floods occur two or three times a year. The recreation area and facilities in and near the community of Red River receive damage from floods coming from the steep canyons adjacent to the town. Several of the lodges and tourist courts are in the floodplain and are subject to extensive damage when high intensity rains occur on the upper portions of the watershed.

This watershed is intensively used by recreation seekers. Many more recreation areas are needed to provide for the ever-increasing vacation load.

Red River New Mexico, a popular resort area (Soil Conservation Service photograph)

SCS PHOTO 12-P392-15

Streambank stabilization is needed along the Red River in many places particularly through the village of Red River.

Waste from the Molybdenum Corporation mine (mine and tailings ponds) need plans for revegetation.

There are also small areas (640 acres total) of a chalky white material that presently supports no vegetation. When these small areas erode they give the Red River its milky appearance. Studies need to be made to determine what kinds of vegetation will stabilize these areas.

Damaging floods are usually caused by high-intensity thunderstorms during the summer months. Flooding also occurs when the snowpack is melted quickly by an unusually warm spring. These spring melts may also be accompanied by rain. Streambank stabilization is needed on Red River particularly through the village of Red River.

Flood damages in the lower reaches of the watershed and around the town of Questa are included in this report. Agricultural water management is needed on all of the irrigated areas. Work is being done under the Northern Rio Grande Resource Conservation and Development project to reorganize and rehabilitate the irrigation systems. More is being planned and designed.

Physical Potential for Meeting Needs

A reconnaissance of the damage area and flood source area indicated that suitable sites are available on which to construct floodwater and sediment detention dams. Adequate borrow material is lacking at site locations and may present problems. All of the sites examined are close to residential areas and are high-hazard sites. Several of the sites are in potential rock slide areas and may present problems during and after construction. This potential will be studied in more detail in early stages of planning.

The irrigation systems can be reorganized and rehabilitated without encountering any major problems. This work is being done under the resource conservation and development project and is not considered here as a part of a proposed Public Law 566 project.

Local Interest in Project Development

Several of the property owners in the damage area have requested assistance in planning and construction of works to protect them from damaging floods. These people are interested in a flood control project to reduce or eliminate flood damage and to enhance the recreational values of the area. These is some opposition to a project, but it is felt the opposition can be overcome by a well-organized information program.

With damage potential reduced, the recreational facilities can be expanded resulting in increased economic returns to the local people. At present, there is not a local organization that can assume the legal and financial responsibilities to carry out a project under Public Law 566.

Works of Improvement for Potential Development

Land Treatment Measures[1/]

This watershed has no critical areas needing protection. Most land on the watershed is managed well. The usual good range management practices are needed. There may be a tendency for small ranch owners to overstock private ranges, however this is not a big problem.

The list of land treatment needs in table 2 represent a development potential more than a need for protection. It is recognized, however, that land treatment will aid in retarding runoff and will reduce erosion.

Structural Measures

From the reconnaissance of the area around Red River, it was determined that flood damage and potential damage occurs in 6 locations. Proposed structural measures for flood protection include 5 floodwater retarding structures and one floodwater diversion. The approximate location of these sites is shown on the attached map. See tables 1 through 4 and figure 1. All flood control structures will be high-hazard class "c" structures.

1/ Refer to Land treatment tables 7 and 8 and figure 1.

Nature and Estimate of Costs of Improvement

From a field reconnaissance and study of United States Geological Survey 7 1/2 minute quad maps of the area, it was determined that feasible sites exist at the selected locations. The drainage area above each proposed flood control structure was determined from the quad map. Cost estimates of the proposed structures were determined from data obtained from the quad maps and a minimum of field surveys. Unit cost for earth embankment to cover all costs except land rights and administration were obtained from a curve developed from costs of completed Public Law 566 watershed work plans where detailed cost estimates have been made. The total estimate includes estimated land rights costs.

It is assumed that the rehabilitation of the irrigation systems is readily justifiable and will be continued under the present program and project; therefore, no estimate of cost of works of improvement is made for this report.

Effects and Economic Feasibility of Potential Development

Damaging floods occur on an average of two or three times each year. Major fixed improvements such as homes, businesses, resort motels, roads and streets receive most damage. (The values of these various improvements range from a few thousand dollars to well over $100,000).

It is estimated that the area flooded by the 100-year frequency storm is about 100 acres. This area is intensively used as a summer and winter resort area and a variety of recreational facilities are located here. The population is highly variable ranging from 500 to 5,000. After the structural works of improvement are installed, the 100-acre area will be fully protected from the 100-year frequency storm. The flood protection provided, along with other development potential, will result in approximately $129,000 average annual benefits. These benefits compare favorably with project cost which is $110,000 annually. This results in a benefit cost ratio of 1.2 to 1 (see tables 5 and 6).

There are approximately 115 owners and operators of major fixed improvements in the watershed that will be directly benefited by the project. In addition, many other people will benefit from the increased participation in a wider variety of recreational activities. Benefits accruing to the general public include flood damage reduction to roads, bridges, streets, culverts, and public utilities.

Recommendations

It appears from the investigations made, that a Public Law 566 project will be the best approach to provide flood control for the area.

The interested local people should submit an application for assistance under Public Law 566. This can be done through the local soil and water conservation district. They should also form an organization with authority to levy and collect taxes on real property; and, with authority of condemnation if necessary to obtain land easements and

rights-of-way. The local organization must also be able to carry out the operation and maintenance of a project.

Because of its location and mountainous terrain, this watershed invites intensive use by the public. This potential use demands that a comprehensive land use plan be developed at the earliest possible time for the entire watershed. This should include plans for summer home site locations, relic areas, recreation areas, utilities (including transportation facilities) waste disposal, etc. Plans should include private and public lands.

Alternate or Additional Possibilities

Subject to the state water laws, one or more of the structures mentioned in this report may serve dual purposes. In addition to flood control, structures can be used for recreation. Site 4 might develop as a boating and fishing area. The other sites are in very steep terrain but could add to the fishing potential for the area.

Table 1, Structure data, Red River Watershed, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Est. Height of dam (feet)	Est. Vol. of fill (cu.yd.)	Principal Spillway: Type	Principal Spillway: Release rate (csm)	Emergency Spillway: Type	Emergency Spillway: % chance of use	Max. surface area em. spill. level (acres)	Struc. classification
1	6.8	79	132,500	RC conduit	8	earth	1	12.5	c
2	10.2	87	216,230	"	8	"	1	21.0	c
3	5.5	90	264,890	"	8	"	1	9.0	c
4	23.7	85	418,371	"	20	"	1	45.0	c
5	4.8	85	179,110	"	8	"	1	7.0	c

Table 2, Channel data, Red River Watershed, Upper Rio Grande Basin, New Mexico

Channel designation	Length of reach (100 ft.)	Watershed area (sq.mi.)	Needed channel capacity (cfs)	Bottom width (ft.)	Depth (ft.)	Velocity in channel (ft/sec)	Estimated Volume of excavation (cu.yds.)
FWD 1	26.4	0.4	200	15	3.1	3.0	8,500

Table 3, Reservoir storage capacity, Red River Watershed, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Sediment	Detention	Total storage capacity	Sediment storage rate 1/
	(sq.mi.)	acre-feet			(ac.ft./sq.mi./yr)
1	6.8	72	372	444	0.11
2	10.2	105	560	665	0.10
3	5.5	60	300	360	0.11
4	23.7	229	1,195	1,424	0.10
5	4.8	53	300	353	0.11

1/ Erosion rates in the watershed range up to 0.50 acre-feet/square mile/ year.

Table 4, Distribution of structural cost-potential development, Red River Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural Measures		Installation Cost				
		Construction	Installation services	Land, easements, and R/W	Administration of contracts	Installation cost
Floodwater retarding structures	1	243,200	136,800	2,000	200	382,200
	2	262,400	147,600	6,000	200	416,200
	3	204,800	115,200	3,000	200	323,200
	4	428,800	241,200	6,000	200	676,200
	5	185,600	104,400	2,000	200	292,200
Floodwater diversion (1/2 mile)		6,960	3,910	5,000	200	16,070
Total		1,331,760	749,110	24,000	1,200	2,106,070

1/ Price base: 1969

Table 5, Estimated average annual flood damage reduction benefits, Red River Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Floodwater			
Urban	129,000	0	129,000
Total	129,000	0	129,000

1/ Based on adjusted normalized prices

Table 6, Annual cost, Red River Watershed, Upper Rio Grande Basin, New Mexico (dollars)

Evaluation unit	Amortization of installation cost 1/	Operation and maintenance cost 2/	Total
Site 1	18,800	1,200	20,000
Site 2	20,400	1,300	21,700
Site 3	15,900	1,000	16,900
Site 4	33,200	2,100	35,300
Site 5	14,300	900	15,200
FWD	800	100	900
Total	103,400	6,600	110,000

1/ Installation cost 1969 price base amortized for 100 years at 4 7/8% interest.
2/ Adjusted normalized prices

Table 7, Comparison of benefits and costs for structural measures, Red River Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Evaluation unit	Estimated annual 2/ project benefits	Average annual cost	Benefit-cost ratio
Site 1	23,478	20,000	1.2:1
Site 2	25,542	21,700	1.2:1
Site 3	19,479	16,900	1.2:1
Site 4	41,409	35,300	1.2:1
Site 5	17,931	15,200	1.2:1
FWD	1,161	900	1.3:1
Total	129,000	110,000	1.2:1

1/ Price base: 1969
2/ All benefits are damage reduction benefits, other sources of benefits were not evaluated.

Table 8, Land treatment for watershed protection and development, Red River Watershed, Upper Rio Grande, New Mexico

Land treatment system	Total acres	Total treatment completed	Total acres remaining	Total needs
1. Grassland	13,542			
1b-Snowpack mgt.	10,021		10,021	5,009
1c-Good range mgt.	3,521			3,521
2. Grazable woodland	21,510			
2a-Pinyon-juniper control	2,150		2,150	1,720
2b-Pinyon-juniper mgt.	19,360		19,360	19,360
3. Brushland	11,978			
3a1-Sagebrush control	6,451	2,800	3,651	3,651
3a2-Sagebrush mgt.	1,613			1,613
3b1-Chaparral control	1,907		1,907	956
3b2-Chaparral mgt.	1,907		1,907	1,907
4. Commercial timber	87,985			
4a-Spruce-fir mgt.	57,728		57,728	8,659
4b-Ponderosa pine mgt.	12,672		12,672	1,900
4c-Aspen mgt.	17,585		17,585	2,638
5. Bottomland	358			
5a-Phreatophyte control	179		179	179
5b-Bottomland mgt.	179		179	179
6. Crop, pasture, hayland	1,204			
6a-Irrigated land	1,050			
6a1-Drainage	200		200	100
6a2-Improved irrigation	1,050	200	850	850
6b-Dryland				
6c-Abandoned cropland	154		154	154
7. Miscellaneous land	1,613			
8. Critical erosion areas	-			
Total acres	138,090			

Table 9, Land treatment needs and impacts (1969-1980), Red River Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Needs treatment (acres)	Total treatment cost $	Impacts - average annual values: Water $	Sediment reduction $	Red meat $	Timber wood $	Cultivated land $	Increased net $ income	Employment man-years
1. Grassland									
1b-Snowpack mgt.	5,009	425,765	22,039	993	-	-	-	23,031	31.9
1c-good range mgt.	3,531	7,015	-	79	1,584	-	-	1,663	.5
2. Woodland									
2a-pinyon-juniper cont.	1,720	29,240	-	169	1,584	-	-	1,717	2.2
2b-pinyon-juniper mgt.	19,360	193,600	-	2,483	11,619	-	-	14,102	14.5
3. Brushland									
3a1-Sagebrush control	3,651	43,812	-	452	8,217	-	-	8,669	3.3
3b1-Sagebrush mgt.	1,613	24,195	7,392	203	3,627	-	-	11,222	1.8
3a2-Chaparral control	956	5,736	-	113	1,080	-	-	193	.4
3b2-Chaparral mgt.	1,907	14,302	-	248	2,142	-	-	2,390	1.1
4. Commercial timber									
4a-Spruce-fir mgt.	8,659	346,360	31,749	451	9,738	34,203	-	76,141	25.9
4b-Ponderosa-pine mgt.	1,900	57,000	1,742	90	2,142	7,315	-	11,289	4.3
4c-Aspen mgt.	2,638	79,140	9,673	135	2,970	607	-	13,385	5.9
5. Bottomland									
5a-Phreatophyte cont.	179	5,370	5,907	-	1,611	-	-	7,518	.3
5b-Management	179	1,790	-	-	405	-	-	405	.1
6. Cultivated									
6a-Irrigated land									
6a1-Drainage	100	2,000	-	-	-	-	7,500	7,500	.1
6a2-Improved irrigation	850	93,500	-	-	-	-	63,750	63,750	7.0
6b-Dryland									
6c-Abandoned cropland	154	2,310	-	1,129	1,386	-	-	2,515	.2
7. Miscellaneous									
8. Critical									

LEGEND

(2)	SITE NUMBER
	FLOODWATER RETARD STR.
	FLOODWATER DIVERSION
1b	SNOW PACK MANAGEMENT
1c	GOOD RANGE MANAGEMENT
2a	PINYON-JUNIPER CONTROL
2b	PINYON-JUNIPER MANAGEMENT
3-1	SAGEBRUSH CONTROL & MGT.
3-2	CHAPARRAL CONTROL & MGT.
4a	SPRUCE-FIR MANAGEMENT
4b	PONDEROSA PINE MANAGEMENT
4c	ASPEN MANAGEMENT
5	BOTTOMLAND VEGETATION MGT.
6	IRRIGATED LAND MANAGEMENT
6c	ABANDONED CROPLAD MGT.
7	MISCELLANEOUS LAND

N

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

RED RIVER WATERSHED
UPPER RIO GRANDE BASIN

SCALE 1" = 2 MI.

APPROX. SCALE 1:125,000

1969

EMBUDO CREEK WATERSHED INVESTIGATION
Upper Rio Grande Basin
Taos and Rio Arriba Counties, New Mexico
CNI 1-151

The Watershed in Brief

The watershed is a tributary to the Rio Grande and is located in eastern Rio Arriba County and Southeastern Taos County. Embudo Creek is the principal stream and enters the Rio Grande near the town of Embudo. Several other small towns are located in the watershed. The watershed is about 18 miles northeast of Espanola and 27 miles southwest of Taos. There are 204,770 acres (320 square miles) in the watershed. Eighty-one percent of the area is administered by federal agencies, 2 percent is state land, and 17 percent private land.

The Embudo Creek Watershed lies in a mountainous area. Mean sea level elevations range from 13,306 feet above on North Truchas Peak to 5,800 feet where Embudo Creek enters the Rio Grande.

The average annual precipitation ranges from 10 inches at Dixon to 35 inches in the high mountains. The 35-year average flow of Embudo Creek at Dixon is 80.5 cubic feet per second.

The principal land use is for grazing livestock. Commercial timber and forest products are a minor contributor to the economy of the area. There are about 8,400 acres of irrigated land along the benches and in the valleys of the perennial streams. The irrigated areas range in elevation from about 5800 to 8000 feet above mean sea level. The principal crops grown are small grains, grass, hay, and pasture with some fruit and vegetables.

The watershed is located in the Espanola basin of the Southern Rocky Mountains physiographic province. It is underlain by sediments of the Ancha and Tesuque geologic formations of the Santa Fe Group.

Watershed Problems and Needs

There are 41 community irrigation ditch systems serving the irrigated areas. A major problem in the watershed is the lack of sufficient water during the peak-use period for crops. This problem is caused by : (1) the inability of the irrigation systems to effectively deliver the low flows of the streams to the farm headgates, and (2) the interruption of irrigation service. This is caused by floodwater where ditches cross arroyos. Ditch breaks and sediment accumulations in the ditches are common during the irrigation season. Approximately 60 percent of the flood damage is to the irrigation systems and the loss of crop production from the interrupted water delivery. Floodwater damage to highways is high. Damages caused by washouts and sediment deposition are experienced annually in the vicinity of Embudo.

1967 flood damage to highway at Dixon below proposed site 1.
(Soil Conservation Service photograph)

SCS PHOTO 12-P576-2

The major needs of the watershed are to (1) consolidate, reorganize, and rehabilitate the irrigation systems, (2) construct floodwater retarding structures at selected locations, and (3) provide streamflow regulation. This will include diversion and water control structures and ditch lining. The flood damages can be reduced about 80 percent by the construction of six floodwater retarding structures in the lower reaches of the watershed. About 20 percent of the irrigated land needs drainage.

Physical Potential for Meeting Needs.

The principal measure in the watershed to reduce the flood hazard and flood potential is management on federally administered land. Very few control structures have been installed.

Many of the landowners are cooperators with the local soil and water conservation district and are encouraged to apply applicable conservation measures.

The topography, soil, and geology of the watershed are generally favorable for structural measures to effectively solve much of the flooding problem. Field and map reconnaissance indicates suitable sites for retarding structures are available. There are no major physical limitations to improving the irrigation systems and irrigation efficiency; however, some of the local water users appear to be unwilling to consolidate the irrigation ditches.

A structure located above Penasco could be installed for irrigation and recreation water storage.

Local Interest in Project Development

In December 1962, local sponsoring organizations submitted to the Secretary of Agriculture an application for assistance with a project under Public Law 566. In June 1964, a field examination and report was completed by the Soil Conservation Service. The examination concluded that some flood protection measures probably could be justified in connection with agricultural water management measures.

The Embudo Watershed Association has been formed by the local people, and they have expressed a willingness to participate financially in accordance with their capabilities and their share of the costs of a project. These costs will include obtaining easements and rights-of-way and performing necessary operation and maintenance of the structural measures.

In the Upper Dixon area the landowners have developed a plan (RC&D Project Measure No. 130) to reorganize and rehabilitate with control structures and canal lining the Acequia del Medio (community irrigation ditch).

Works of Improvement for Potential Development

Land Treatment Measures

The most critical land treatment area is the Cascajo-Rough Broken Land Soil Association that supports a scattered to dense stand of pinyon-juniper trees. This is a high-sediment producing area. Intensive grazing management (including limited livestock use or exclusion) coupled with small gully control, selective thinning of pinyon-juniper on better soil-slope sites and reseeding disturbed areas would aid in reducing sediments delivered to structure sites downstream. About 20 percent of the woodlands on moderately deep soils and moderate slopes could be cleared and reseeded to forage-producing grasses.

About 20 percent of the irrigated land needs drainage of some kind, and 90 percent needs improved irrigation facilities. This will include ditch lining, land leveling, irrigation water management and redesigned field irrigation systems. Much of the drainage problem can be alleviated by improved irrigation systems.

There is a good potential in this watershed for improved economy by growing Christmas trees. The land and the climate are favorable for this type of venture. There is also potential for landowners to lease part of their property to urban "summer home site" seekers. In order to entice these prospective lessees, the private property needs to be improved. This can be accomplished by controlling gullies, thinning pinyon-juniper trees, clearing willows, reseeding barren ground, and improving irrigation systems. (See tables 7 and 8 and figure 1).

Structural Measures

Structural measures considered for development in the watershed are:

1. Six flood prevention structures. The locations are shown on the attached map. Approximately 2.5 percent of the watershed area is controlled by these structures. This will reduce flood damages in the immediate vicinity of the structures by approximately 80 percent. All floodwater retarding structures are high-hazard class "c" structures.

2. Irrigation system rehabilitation, water control structures, and ditch lining as needed for the approximately 8,400 acres of irrigated land.

3. Construct subsurface drainage systems with appurtenant structures on about 1,850 acres of irrigated land. (See tables 1 through 3 and figure 1).

Nature and Estimate of Cost of Improvements

A field reconnaissance using U. S. Geological Survey 7 1/2 minute quad maps was made of the possible floodwater retarding structure sites and the irrigation systems needing rehabilitation.

The estimate of cost for the floodwater retarding structures was made by estimating the quantity of earthfill required for a dam and using unit cost data from completed watershed work plans where detailed cost estimates have been made in similar conditions in New Mexico. The principal items of work in the structures will be earthmoving, both excavation and embankment. The estimate of cost for irrigation facilities was based on a cost per acre of development as estimated for the RC&D project measure no. 130, improvement of Acequia del Medio. The major items in the proposed works would be permanent-type diversion dams and concrete lining. Estimated cost of subsurface drainage is based on costs of similar projects in other locations. The principal item of work in subsurface drainage will be excavation. Land rights, easements, and rights-of-way will not be a major problem or cost. There are no roads nor utilities that would have to be relocated as a result of the proposed improvements.

Effects and Economic Feasibility of Potential Development

Damage reduction benefits evaluated will accrue almost entirely to flood damages sustained by public roads, ditch culverts, and related appurtenances. The major damage area is located where highways and other roads cross the arroyos. Six floodwater retarding structures are planned which will provide a high degree of protection to the damage area. It is expected that flood damages will be reduced by about 80 percent. Floodwater damages without project conditions are estimated to be $46,400. Damage reduction benefits accruing to structural measures will be about $37,120 annually.

The annual equivalent cost of flood protection measures is $38,000 and, when compared with flood prevention benefits of $37,100, will provide a benefit-cost ratio of 1.0 to 1.

Agricultural water management benefits resulting from rehabilitated irrigation systems will amount to approximately $62,000 annually and will accrue on about 8,400 acres of land presently under irrigation. There are about 1,250 farmers in the watershed who will be benefited by rehabilitation of the irrigation systems.

Structural measures for agricultural water management will have an annual cost of $25,000 and average annual benefits of $62,000. Comparison of these benefits and costs will yield a benefit-cost ratio of 2.5 to 1. (See tables 5 and 6).

Alternate or Additional Possibilities

The U. S. Forest Service and the Bureau of Reclamation have investigated a potential dam site east of Penasco on Santa Barbara Creek. A dam in this location would provide recreation, streamflow regulation and some floodwater prevention benefits.

Table 1, Structure data, Embudo Creek Watershed, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Est. Height of dam (feet)	Est. Vol of fill (cu.yd.)	Principal Spillway Type	Principal Spillway Release rate (csm)	Emergency spillway Type	Emergency spillway % chance of use	Max. surface area em. spill. level (acres)	Hazard class
1	2.48	69	386,955	RC conduit	8	earth	1	39	c
2	1.53	49	138,209	RC conduit	8	earth	1	12	c
3	1.76	48	78,519	RC conduit	8	earth	1	17	c
4	1.10	53	126,407	RC conduit	8	earth	1	12	c
5	0.14	35	34,154	RC conduit	20	earth	1	7	c
6	0.74	44	124,773	RC conduit	15	earth	1	8	c

Table 2, Reservoir storage capacity, Embudo Creek Watershed, Upper Rio Grande Basin, New Mexico

Site number	Drainage area	Storage capacity planned			Sediment storage rate 1/
		Sediment	Detention	Total	
	sq. mi.	acre-feet			ac.ft./sq.mi./yr.
1	2.48	806	235	1041	3.25
2	1.53	217	130	347	1.41
3	1.76	250	150	400	1.42
4	1.10	156	85	251	1.42
5	0.14	20	13	33	1.43
6	0.74	105	67	172	1.42

1/ Erosion rates in the watersheds range up to 5.0, or more, acre-feet/ square mile/year.

Table 3, Distribution of structural cost-potential development, Embudo Creek Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural Measures		Installation cost				
		Construction	Installation services	Land, easements and R/W	Administration of contracts	Installation cost
Floodwater retarding structures	1	165,930	93,330	1,500	200	260,960
	2	76,070	42,790	1,400	200	120,460
	3	50,250	38,270	1,000	200	79,720
	4	70,380	39,590	1,000	200	111,170
	5	32,790	18,440	1,000	200	52,430
	6	69,470	39,080	1,000	200	109,750
Irrigation facilities		294,000	165,000	-	2,000	461,000
Subsurface drainage		5,100	2,900	-	200	8,200
Total		763,990	429,400	6,900	3,400	1,203,690

1/ Price base: 1969

Table 4, Estimated average annual flood damage reduction benefits, Embudo Creek Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Floodwater			
Agricultural	46,400	9,280	37,120
Total	46,400	9,280	37,120

Table 5, Annual cost, Embudo Creek Watershed, Upper Rio Grande Basin, New Mexico

Evaluation unit	Amortization of installation cost (dollars) 1/	Operation and maintenance cost (dollars) 2/	Total (dollars)
Site 1	12,800	500	13,300
Site 2	5,900	400	6,300
Site 3	3,900	400	4,300
Site 4	5,500	300	5,800
Site 5	2,600	100	2,700
Site 6	5,400	200	5,600
Irrigation and drainage facilities	23,100	1,900	25,000
Total	59,200	3,800	63,000

1/ Amortized at 4 7/8% interest for 100 years
2/ Adjusted normalized prices

Table 6, Comparison of benefits and costs for structural measures, Embudo Creek Watershed, Upper Rio Grande Basin, New Mexico

Evaluation unit	Estimated annual benefits (dollars)	Estimated average annual cost (dollars)	Benefit-cost ratio
Site 1	12,900	13,300	1.0:1
Site 2	7,400	6,300	1.2:1
Site 3	8,400	4,300	2.0:1
Site 4	5,300	5,800	0.9:1
Site 5	700	2,700	0.3:1
Site 6	3,500	5,600	0.6:1
Irrigation and drainage facilities	62,000	25,000	2.5:1
Total	100,200	63,000	1.6:1

NOTE: Benefits are all damage reduction benefits, other sources of benefits were not evaluated.

Table 7, Land treatment for watershed protection and development, Embudo Creek Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Total acres	Total treatment completed	Total acres remaining	Total needs
1. Grassland	12,851			
1b-Snowpack mgt.	6,195	50	6,145	620
1c-Good range mgt.	6,656			6,656
2. Grazable woodland	51,610			
2a-Pinyon-juniper control	8,141	300	7,841	5,760
2b-Pinyon-juniper mgt.	36,425			36,425
3. Brushland	973			
3b2-Chaparral mgt.	973			973
4. Commercial timber	130,022			
4a-Spruce-fir mgt.	71,655		71,655	10,901
4b-Ponderosa pine mgt.	39,987	1,200	38,987	10,435
4c-Aspen mgt.	18,380		18,380	2,900
5. Bottomland				
6. Crop, pasture, hayland	9,322			
6a-Irrigated land	8,400			
6a1-Drainage	1,950	100	1,850	1,850
6a2-Improved irrigation	8,280	1,200	7,080	2,360
6b-Dryland				
6c-Abandoned cropland	922		922	922
7. Miscellaneous				
8. Critical erosion area	7,040		7,040	7,040
Total acres	204,770			

Table 8, Land treatment needs and impacts (1969-1980), Embudo Creek Watershed, Embudo Creek Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Needs treatment (acres)	Total Treatment cost $	Impacts - Average Annual Values						
			Water $	Sediment reduction $	Red meat $	Timber wood $	Cultivated land $	Increased net income $	Employment man-years
1. Grassland									
1b-Snowpack mgt.	620	52,700	2,728	113	2,997			2,841	3.9
1c-Good range mgt.	6,656	3,328		10,816	2,997			13,813	.3
2. Woodland									
2a-Pinyon-juniper control	5,760	97,920		523	5,184			5,737	7.3
2b-Pinyon-juniper mgt.	36,425	364,250		4,335	21,852			26,187	27.3
3. Brushland									
3b2-Chaparral mgt.	973	7,298		113	1,098			1,211	.5
4. Commercial timber									
4a-Spruce-fir mgt.	10,901	436,040	39,970	519	12,267	43,059		95,815	32.7
4b-Ponderosa pine mgt.	10,435	313,050	9,565	497	11,736	40,175		61,973	23.5
4c-Aspen mgt.	2,900	87,000	10,633	135	3,258	667		14,693	6.5
5. Bottomland									
6. Cultivated land									
6a-Irrigated land									
6a1-Drainage	1,850	37,000					138,750	138,750	2.8
6a2-Improved irrigation	2,360	259,600					177,000	177,000	19.5
6b-Dryland									
6c-Abandoned Cropland	922	13,830		11	8,298			8,309	1.0
7. Miscellaneous									
8. Critical erosion areas	7,040	105,600		7,948	15,840			23,788	7.9

LEGEND

	FLOODWATER RETARD STR.
(2)	SITE NUMBER
1b	SNOW PACK MGT
1c	GOOD RANGE MGT.
2a	PINYON-JUNIPER CONTROL
2b	PINYON-JUNIPER MGT.
3-2	CHAPARRAL MGT.
4a	SPRUCE-FIR MGT.
4b	PONDEROSA PINE MGT.
4c	ASPEN MGT.
6a	IRRIGATED LAND MGT.
6b	DRY LAND MGT.
6c	ABANDONED CROPLAND MGT.
8	CRITICAL EROSION AREA

STRUCTURE LOCATION AND LAND TREATMENT MAP

EMBUDO CREEK WATERSHED UPPER RIO GRANDE BASIN

APPROX. SCALE 1:140,000

1969

POJOAQUE CREEK WATERSHED INVESTIGATION
Upper Rio Grande Basin
Santa Fe County, New Mexico
CNI 1-144

The Watershed in Brief

The Pojoaque Creek Watershed is located in Santa Fe County, beginning approximately five miles north of the City of Santa Fe. The watershed has an area of about 153,555 acres (240 square miles) of which 201 square miles are covered by a Public Law 566 watershed application. This watershed is approximately 22 miles in length and ranges from about 11 miles wide in the upper reaches to about 6 miles wide in the lower part.

Mean sea level elevations range from about 12,600 feet in the mountains to about 5,500 feet where Pojoaque Creek enters the Rio Grande. Major tributaries to Pojoaque Creek are the Rio Tesuque, Rio Nambe, Rio en Medio, Rio Chupedero, and Arroyo Seco. Arroyo Seco is not included in the PL 566 application.

The watershed is in the Southern Rocky Mountains Physiographic Province, with the higher elevations in the Southern Rocky Mountain Land Resource Area and most of the lower elevations in the New Mexico Arizona Plateaus and Mesas Land Resource Area.

The average annual precipitation ranges from about 9 inches in the valley to more than 30 inches in the mountains.

The principal land use is for livestock grazing, with some timber land included and about 3,800 acres of irrigated land serviced by 45 ditches and 32 separate diversions. The principal crops grown on the irrigated land are alfalfa, small grains, corn, fruit, and vegetables.

Approximately 16 percent of the land is privately owned, 1 percent is state owned, 43 percent is federal land, and 40 percent is Indian land.

The watershed is in the Northern Rio Grande Resource Conservation and Development area. Improvement is being made on some of the irrigation systems under this program.

Watershed Problems and Needs

High intensity rains which occur from June through September fall on steep slopes with sparse vegetation and cause extensive gully development and frequent damaging floods. The major flood and sediment damage results from tributary flows that enter Pojoaque Creek. This damage includes washing out irrigation ditches, depositing sediment in ditches, crop damage from floodwater and sediment deposition, damage to canal headings and diversions from the streams, and damage to homes, businesses and personal property. Sediment deposited in the stream channels is

causing aggradation. This results in more frequent flooding of adjacent land.

Flood damage is sustained each year on the major tributaries and the main stem of Pojoaque Creek. Floods causing considerable damage occurred in 1951, 1952, 1954, 1955, 1957, 1958, 1963, and 1965. The largest flood occurred in 1955 and inundated 267 acres of cropland. The larger floods cause damage to State Highway 4 which parallels Pojoaque Creek as well as county and private roads. Private roads and crossings were damaged by small floods on Rio Nambe and Pojoaque Creek.

Erosion ranges from moderate to severe over all of the watershed except in the high mountain areas. The foothill area is the most severely eroded area in the watershed. Streambank erosion causes the damage to cropland through actual land loss. Floodwater retarding structures for flood protection and land treatment measures for sediment reduction and watershed protection are needed.

Shortages of water for irrigation during the growing season is a major problem in the watershed. This problem can be partially eliminated by a reorganization and rehabilitation of the distribution systems. Some streamflow regulation for irrigation is needed.

Brush control and grass seeding on Nambe Pueblo range. (Soil Conservation Service photograph) SCS PHOTO 12-P303-1

Physical Potential for Meeting Needs

Very few flood prevention measures have been established within the watershed. There are a few locally effective erosion control and detention dams on Indian lands. Some streambank protection measures have been installed. Both are generally inadequate. Many of the landowners are cooperators with the local soil and water conservation district and are applying a few applicable conservation measures.

Field reconnaissance indicates that the topography, soils, and geology of the watershed are favorable for installation of structural measures which would effectively solve the problems caused by flooding. Many of the irrigation water management problems can also be solved. Sites for flood detention structures and outlet channels are available and adequate to solve much of the flood problem. Improved water management measures are stressed by the local soil and water conservation district. This can and is solving part of the problem.

There is a possible site location for a multiple purpose structure on Nambe Creek in which storage for recreation and irrigation water in addition to flood prevention may be provided.

Local Interest in Project Development

An application for a Public Law 566 flood protection project was submitted in January 1955. A preliminary investigation and report was completed in March 1958. The project was determined to be economically unfeasible at that time. Further evaluation and preparation of a watershed work plan showed a favorable benefit-cost ratio. Because of opposition from landowners in the upper watershed, watershed planning assistance was terminated. Landowners in the Tesuque area have indicated an interest in being re-included in the project application since the floods during the summer of 1968. The Pojoaque Watershed District was legally reorganized in 1968 as a sub-district of the Santa Fe-Pojoaque Soil and Water Conservation District. This will meet the requirements for adequate local sponsorship of a public law 566 project.

Since the PL 566 work plan was terminated, interest has been shown by some local landowners to construct parts of the flood protection structures under other programs.

Local sponsors have indicated a willingness and a financial ability to assume their share of project costs. These costs will include obtaining easements and rights-of-way and performing necessary operation and maintenance of structural measures.

Works of Improvement for Potential Development

Land Treatment Measures

Approximately 15 percent of the grasslands are in critical need of special erosion control and restoration practices. These areas are usually near

farmsteads, cultivated fields and villages where pasturing animals over uses available forage.

Treatment will include exclusion or limited livestock use, small gully control, water spreading devices, grazing land mechanical treatment and seeding to adapted grasses. Soil, climatic, and topographic conditions combine to make land treatment difficult in the lower reaches of this watershed. Areas of badlands should be treated to keep sediment eroding from them as close to the badland area as possible. Small gully plugs, net wire fences, contour furrows, diversions, and seeding treated areas are a few of the practices that can be employed.

Grazing management is needed on all areas. Most of the rangeland below the ponderosa pine line is suffering from overuse. Grazing systems including deferred grazing, rotation-deferred grazing and better livestock distribution through use of fencing and watering facilities are the main practices.

Additional land treatment measures are land leveling, ditch construction, rehabilitation and lining; water control structures, improved water management and cover crops. (See tables 6 and 7, and figure 1).

Structural Measures for Flood Prevention

Twenty-two flood retarding structure sites were studied to determine feasibility. Of the sites investigated, five appear to be economically feasible under Public Law 566 criteria for project evaluation. The benefit-cost ratio on 3 other sites indicated that more detailed evaluation is warranted. (See tables 1, 2, and 3, and Figure 1). Some of the other sites investigated might be justified if a detailed economic evaluation is undertaken.

The Pojoaque Unit of the San Juan-Chama Project of the United States Bureau of Reclamation is within the watershed. The project will consist of a storage reservoir on Nambe Creek that will store about 1500 acre-feet of water.

Nature and Estimate of Costs of Improvements

Investigation of the structure sites and damage of flooded areas was made by field and map reconnaissance with a minimum of field surveys. Both aerial photos and U. S. Geological Survey 7 1/2 minute quad maps were used to outline flooded and contributing areas.

The costs for the construction and installation of floodwater retarding structures were estimated by curves developed by the watershed planning staff which give structure cost versus drainage area controlled. The principal items of work will be earthfill. Two of the structures will have a reinforced concrete emergency spillway. All structures will be high-hazard class "c" structures.

Land rights, easements, and rights-of-way will not be a major problem or cost. There are no roads or utilities that will have to be relocated as a result of the structures.

Effects and Feasibility of Potential Development

The annual project cost for structural measures is $121,500 which includes $3,600 for operation and maintenance. When this cost is compared with estimated average annual benefits of $143,400, a benefit-cost ratio of 1.2 to 1 is calculated. (See table 5).

Alternates or Additional Possibilities

The Nambe Creek structure planned by the Bureau of Reclamation has good possibilities for recreation in addition to irrigation and floodwater purposes.

The current PL 566 watershed application includes an area west of the Rio Grande. Protective measures for this area cannot be justified under PL 566 criteria; however, it is possible that some of the works needed can be provided under the resource conservation and development program or other programs.

Table 1, Structure data, Pojoaque Watershed, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Est. height of dam (feet)	Est. vol. of fill (cu.yd.)	Principal spillway Type	Principal spillway Release rate (csm)	Emergency spillway Type	Emergency spillway % chance of use	Max. surface area emer. spwy. level (acres)	Hazard class
1	3.5	74	143,426	RC conduit	12	earth	1	19.5	c
2	10.3	93	367,466	RC conduit	8	earth	1	35.0	c
3	13.3	62	211,836	RC conduit	8	earth	1	54.0	c
4	1.4	36	132,319	RC conduit	12	earth	1	13.5	c
7	4.9	38	279,889	RC conduit	10	earth	1	52.0	c
10	2.6	40	78,967	RC conduit	12	earth	1	70.0	c
11	10.7	45	222,515	RC conduit	8	earth	1	77.0	c
12	5.3	37	141,432	RC conduit	10	earth	1	45.0	c

Table 2, Reservoir storage capacity, Pojoaque Creek Watershed, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Storage capacity planned in acre feet: Sediment	Detention	Subtotal flood prev.	Total	Sediment storage rate 1/ (ac.ft./sq.mi./yr.)
1	3.5	213	273	486	486	0.61
2	10.3	546	685	1,231	1,231	0.53
3	13.3	652	861	1,513	1,513	0.50
4	1.4	72	125	197	197	0.51
7	4.9	260	370	630	630	0.53
10	2.6	139	220	359	359	0.53
11	10.7	567	787	1,354	1,354	0.53
12	5.3	281	413	694	694	0.52

1/ Erosion rates range as high as 4.0 acre feet per square mile per year in the watershed.

Table 3, Distribution of structural cost-potential development, Pojoaque Creek Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures		Installation cost				
		Construction	Installation services	Land, easements and r. w.	Administration of contracts	Installation cost
Floodwater retarding structures						
	1	141,440	79,560	5,000	200	226,200
	2	265,600	149,400	2,500	200	417,700
	3	291,200	163,800	2,000	200	457,200
	4	67,840	38,160	1,000	200	107,200
	7	179,200	100,800	1,000	200	281,200
	10	112,000	63,000	1,000	200	176,200
	11	268,800	151,200	1,000	200	421,200
	12	198,400	111,600	1,000	200	311,200
Total		1,524,480	857,520	14,500	1,600	2,398,100

1/ Price base: 1969

Table 4, Estimated average annual flood damage reduction benefits, Pojoaque Creek Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Floodwater			
Agriculture	175,942	71,361	104,581
Total	175,942	71,361	104,581

1/ Based on adjusted normalized prices

Table 5, Comparison of benefits and costs for structural measures, Pojoaque Creek Watershed, Upper Rio Grande Basin, New Mexico

Structures	Amortization of installation cost 1/	Av. annual operation & maintenance cost 2/	Average annual cost	Estimated average annual benefits	Benefit-cost ratio
	(dollars)	(dollars)	(dollars)	(dollars)	
Site 1	11,100	500	11,600	9,500	0.8:1
Site 2	20,500	200	20,700	39,500	1.9:1
Site 3	22,500	1,000	23,500	33,700	1.4:1
Site 4	5,300	100	5,400	5,900	1.1:1
Site 7	13,800	700	14,500	12,000	0.8:1
Site 10	8,700	400	9,100	7;000	0.8:1
Sites 11 & 12	36,000	700	36,700	35,800	1.0:1
Total	117,900	3,600	121,500	143,400	1.2:1

1/ Amortized at 4 7/8 % interest for 100 years
2/ Adjusted normalized prices

Table 6, Land Treatment for watershed protection and development, Pojoaque Creek Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Total acres	Total treatment completed	Total acres remaining	Total needs
1. Grassland				
1b-Snow pack mgt.	1,794		1,794	190
1c-Good range mgt.	3,200			3,200
2. Grazable woodland				
2a-Pinyon-juniper control	1,575	275	1,300	1,150
2b-Pinyon-juniper mgt.	71,420			71,420
3. Brushland				
3b1-Chaparral control	998		998	998
3b2-Chaparral mgt.	2,984		2,984	2,984
4. Commercial timber				
4a-Spruce-fir mgt.	21,004		21,004	5,231
4b-Ponderosa pine mgt.	6,349		6,349	635
4c-Aspen mgt.	7,432		7,432	743
5. Bottomland				
5a-Phreatophyte control	460		460	230
5b-Bottomland mgt.	462		462	462
6. Crop, pasture, hayland				
6a-Irrigated land	3,800			
6a1-Drainage	40		40	40
6a2-Improved irrigation	3,800	315	3,485	3,050
6b-Dryland				
6c-Abandoned cropland	107		107	107
7. Miscellaneous land				
8. Critical erosion areas	32,960		32,960	32,960

Table 7, Land treatment needs and impacts (1969-1980) Pojoaque Creek Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Needs treatment (acres)	Total treatment cost $	Impacts - average annual values: Water $	Sediment reduction $	Red meat $	Timber wood $	Cultivated land $	Increased net income $	Employment man-years
1. Grassland									
1b-Snowpack mgt.	190	16,150	836	33				869	1.2
1c-Good range mgt.	3,200	1,600		67	1,440			1,507	.1
2. Woodland									
2a-Pinyon-juniper con.	1,150	19,550		113	1,035			1,148	1.5
2b-Pinyon-juniper mgt.	71,420	714,200		9,178	42,849			52,027	53.5
3. Brushland									
3a2-Chaparral control	998	5,988		113	1,125			1,238	.4
3b2-Chaparral mgt.	2,994	22,455		383	3,366			3,749	1.7
4. Commercial timber									
4a-Spruce-fir mgt.	5,251	210,040	19,254	271	5,904	20,741		46,170	15.8
4b-Ponderosa pine mgt.	635	19,050	583	23	711	2,425		3,742	1.4
4c-Aspen mgt.	743	22,290	2,724	34	837	171		3,766	1.7
5. Bottomland									
5a-Phreatophyte cont.	230	6,900	7,590		2,070			9,660	.5
5b-Bottomland mgt.	462	4,620			1,044			1,044	.3
6. Cultivated									
6a-Irrigated land									
6a1-Drainage	40	800					3,000	3,000	.1
6a2-Improved irrigation	3,050	335,500					228,750	228,750	25.2
6c-Abandoned cropland management	107	1,605	2		963			965	.1
7. Miscellaneous									
8. Critical erosion area	32,960	494,400		40,181	74,160			114,341	37.1

LEGEND

◀	FLOODWATER RETARD STR.
②	SITE NUMBER
1b	SNOW PACK MGT.
1c	GOOD RANGE MGT.
2a	PINYON-JUNIPER CONTROL
2b	PINYON-JUNIPER MGT.
3-2	CHAPARRAL CONTROL & MGT.
4a	SPRUCE FIR MGT.
4b	PONDEROSA PINE MGT.
4c	ASPEN MGT.
5	BOTTOMLAND VEGETATION MGT.
6a	IRRIGATED LAND MGT.
6c	ABANDONED CROPLAND MGT.
8	CRITICAL EROSION AREA
• • •	BOUNDARY OF WATERSHED WITH P.L. 566 APPLICATION

STRUCTURE LOCATION AND LAND TREATMENT MAP

POJOAQUE CREEK WATERSHED UPPER RIO GRANDE BASIN

SCALE 1" = 2 MI.

APPROX. SCALE 1:125,000

1969

SANTA FE RIVER WATERSHED INVESTIGATION
Upper Rio Grande Basin
Santa Fe County, New Mexico
CNI 1-140

The Watershed in Brief

The Santa Fe River Watershed heads in the Sangre de Cristo Mountains at Lake Peak - elevation 12,409 feet above mean sea level and drains in a southwesterly direction to the Rio Grande, elevation 5200 feet above mean sea level. It is 36 miles long, seven miles wide, and has an area of about 164,300 acres (257 square miles). The city of Santa Fe is located approximately in the center of the watershed. A State Enabling Act in 1930 and a 1932 cooperative agreement between the United States Department of Agriculture, the New Mexico Power Company, and the city of Santa Fe has excluded the upper one-fourth of the watershed from human use for the past 37 years. Except for well water, this area is the source of water for Santa Fe. Approximately 46 percent of the land is privately owned, 12 percent is state, 40 percent is federal land, and about 2 percent is Indian land. The watershed is in the Northern Rio Grande Resource Conservation and Development area.

Mountain area of Santa Fe River Watershed (Forest Service photograph)

Watershed Problems and Needs

A major problem in this watershed is floodwater and sediment damage in the city of Santa Fe. High intensity thunderstorms on the watershed near the city produce uncontrolled flooding which damages houses, businesses, streets and bridges in urban areas.

The problem has been intensified by the expansion of the urban areas into the pinyon-juniper woodlands north of town. The houses, patios, driveways, etc. have further increased the runoff from the area.

Two critical erosion areas demanding attention are located (1) on the north and east sides of the city of Santa Fe and (2) on the rangeland surrounding La Cienega community. Both of these areas are severely eroded and present problems to the residents and property owners. The principal area of urban expansion for Santa Fe has been in the pinyon-juniper covered hills on the northside of the city. The instability of soil materials associated with the Santa Fe geologic formation, the steep hills, and the disturbance of the area by building houses and roads and installing utilities, makes this area a high contributor of runoff water and sediment to lower elevations. The intensive network of roads and driveways together with the roofs, patios, and paved recreation areas have reduced the potential rainfall intake area by 15 to 25 percent.

Flood damage from flood of July 25, 1968 at 1133 E. Alameda, Santa Fe (Soil Conservation Service photograph)

SCS PHOTO 12-P784-3

In addition, urbanization has narrowed the stream channels through the city. A combination of the two factors results in floodwater and sediment damaged yards, buildings, and public utilities. To cope with these problems, a comprehensive combined land treatment and structural measure program is needed.

Physical Potential for Meeting Needs

Some streambank protection measures have been installed through the city of Santa Fe and have been effective in preventing floodwater damage from minor storms. Field reconnaissance indicates that the topography and geology of the watershed are favorable for installation of structural measures. Adequate soil material at all sites is available for construction. Improved water management measures are stressed by the local soil and water conservation district. There are three structures upstream from Santa Fe which were installed for storage of city water; however, there is no storage for flood protection provided in these structures.

Local Interest in Project Development

The local people have high interest in installation of works for flood protection. The Corps of Engineers are in the process of making an investigation for flood protection in the city of Santa Fe. The majority of the damages are urban and the Corps of Engineers should be contacted and a statement of their interest in the project received before the Soil Conservation Service encourages an application for assistance under Public Law 566.

The Corps of Engineers have completed a floodplain study which begins several blocks west of St. Francis Drive and extends downstream ten miles. A similar study has been made on Arroyo de los Chamisos and Arroyo Hondo.

Works of Improvement for Potential Development

Land Treatment

Homeowners can be encouraged to protect their property and their neighbors by building diversion structures, planting grass or other erosion control vegetation, thinning the pinyon-juniper brush and controlling small gullies. The property owners and the city need to cooperate on floodwater control and disposal of water from roads and driveways.

The area near La Cienega has suffered from heavy livestock use near the stream and farm headquarters. Limited livestock use, reseeding barren areas, control of small gullies, grazing land mechanical treatment and erosion control diversions are practices that can be employed to reduce the erosion.

About one-third of the pinyon-juniper woodland is adaptable to clearing and reseeding. A study of aerial photographs indicates the invasion of juniper brush on grasslands since 1935 has increased the total woodland area by 25 percent. This invasion is taking place on moderately deep

to deep soils on slopes of less that 15 percent gradient. Approximately 4,000 acres of cholla control has been done on lands administered by the Forest Service. Invasion on grasslands by this plant is a problem on the western half of the watershed.

A small area of oak brush is located around McClure reservoir, and is a potential sediment source to the water impoundments. No plans for conversion to grass or other tree species are under consideration. (See tables 8 and 9 and figure 1).

Structural Measures

The structural measures proposed include three single-purpose floodwater retarding structures and one multiple-purpose structure. The three single-purpose structures are on tributaries to the Santa Fe River. These proposed structures will effectively reduce the flow from the arroyos to a level that the existing river channel can discharge floodwaters without damage.

The proposed multiple-purpose structure (flood protection and municipal water storage) is to be incorporated into the existing Two-Mile Reservoir on the mainstem of the Santa Fe River operated for municipal water by the Public Service Company of New Mexico. The existing structure has a capacity of 406 acre-feet with a dam about 45 feet high. The dam, outlet works, and emergency spillway can be modified and enlarged to permit flood storage from the 100-year chance storm. The structure would also contain the expected sediment yield for 100 years and maintain the existing storage. The four structures will reduce flood flows so that the existing Santa Fe River channel will safely carry the outflow from all four proposed structures plus flows from the uncontrolled areas. At the time of field investigations, the city of Santa Fe was cleaning the vegetation growth and debris from the river channel. This type of channel maintenance is a requirement to maintain the capacity needed under future conditions with project in place. (See tables 1, 2, and 3, and figure 1).

Nature and Estimate of Cost of Improvements

The preliminary design and cost estimate for the proposed structures are of reconnaissance level. They are based on a field inspection, data from aerial photos and United States Geological Survey quadrangle maps. The reservoir capacities and dam quantities were estimated from this data. The unit costs used to estimate the cost were taken from curves of costs and quantities from constructed projects and projects with detailed cost estimates prepared.

Site 1, the Two-Mile Reservoir, is located on National Forest land. There are three old houses that must be removed. The other structures will be located in areas where potential housing development is likely. Therefore, it is estimated that land rights will be relatively expensive. It is not anticipated that a problem will occur in acquiring land for structure locations.

Effects and Feasibility of Potential Development

All floodwater damages and damage reduction benefits evaluated in this report accrue to the urban area of Santa Fe. The extent of economic investigations at this time did not reveal any agricultural damages.

Flood damage information obtained for the flood of August 1968 provided a benchmark for estimating other damages and preparation of a damage-frequency curve. Average annual urban damages without project conditions are estimated to be $39,000. Other damages in the amount of $7,800 will result from indirect sources. Installation of structural measures is expected to provide complete control of these damages, resulting in damage reduction benefits of $46,800 annually.

Other project benefits associated with installation and maintenance of structural measures amount to $12,700 annually. These benefits will accrue to unemployed local labor which will be utilized during installation of project measures and other employment needed for operation and maintenance purposes.

The value of local secondary benefits accruing to the project amount to $3,900. They result from increased production of goods and services made possible by the flood protection project.

The sum of project benefits evaluated amount to $63,400 and when compared to annual equivalent costs of $61,500 will yield a benefit-cost ratio of 1.0 to 1. The benefit-cost ratio is somewhat penalized by the fact that two floodwater retarding structures (no. 3 and 4) have been included in the proposed structural program for which no flood damages were reported for the August 1968 storm; however, it is felt that these two structures would provide protection for a potential flood hazard area. (See tables 5, 6, and 7).

Alternate or Additional Possibilities

The Army Corps of Engineers has prepared a tentative plan of improvement consisting of channalization of both the Santa Fe River and Arroyo Mascaras. This plan was presented to local interests for their consideration. The main objection was the proposed channelization of the Santa Fe River through the city park area. At present the plan is being revised and is scheduled for completion by July 1969.

Table 1, Structure data, Santa Fe River Watershed, Upper Rio Grande Basin, New Mexico

Site Number	Drainage area (sq.mi.)	Est. height of dam (feet)	Est. vol. of fill (cu.yd.)	Principal spillway Type	Principal spillway Release rate (csm)	Emergency spillway Type	Emergency spillway % chance of use	Max. surface area emergency spillway level (acres)
1	26.3	80	532,760	RC conduit	8	RC chute	1	45
2	1.9	64	135,400	RC conduit	20	earth	1	15
3	1.9	45	131,500	RC conduit	20	earth	1	25
4	1.0	37	48,200	RC conduit	20	earth	1	13

Table 2, Reservoir storage capacity, Santa Fe River Watershed, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Storage capacity planned: Sediment (acre-feet)	Detention (acre-feet)	Subtotal flood prev. (acre-feet)	Water Supply (acre-feet)	Total (acre-feet)	Sediment storage rate 1/ (ac.ft./sq.mi./yr.)
1	26.3	83	1,050	1,133	406	1,539	0.03
2	1.9	67	196	263	0	263	0.35
3	1.9	158	196	354	0	354	0.83
4	1.0	89	103	912	0	912	0.89

1/ Erosion rates in the watershed range as high as 2.0 acre-feet per square mile per year.

Table 3, Distribution of structural cost-potential development, Santa Fe River Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Construction	Installation cost: Installation services	Land easements and r.w.	Administration of contracts	Installation cost
Two-Mile Reservoir Site 1	586,350	195,450	15,000	500	797,300
Canada Ancha Site 2	101,550	33,850	10,000	200	145,600
Arroyo de la Piedra Site 3	98,625	32,875	10,000	200	141,700
Arroyo Barranca Site 4	54,200	18,000	10,000	200	82,400
Total	840,725	280,175	45,000	1,100	1,167,000

1/ Price base: 1969

Table 4, Estimated average annual flood damage reduction benefits, Santa Fe River Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Item	Estimated average annual damage: Without project	With project	Damage reduction benefits
Floodwater, urban	39,000	-	39,000
Indirect	7,800	-	7,800
Total	46,800	0	46,800

1/ Based on adjusted normalized prices

Table 5, Annual cost, Santa Fe River Watershed, Upper Rio Grande Basin New Mexico

Evaluation unit	Amortization of installation cost dollars 1/	Operation and maintenance cost dollars 2/	Total annual cost
Floodwater retarding structures 1, 2, 3, & 4	57,300	4,200	61,500
Total	57,300	4,200	61,500

1/ Amortized for 100 years at 4 7/8% interest.
2/ Adjusted normalized prices

Table 6, Comparison of benefits and costs for structural measures (dollars) 1/

Evaluation unit	Average annual benefits: Flood prevention damage reduction	Redevelopment	Secondary	Total	Average annual cost	Benefit-cost ratio
Floodwater retarding structures 1, 2, 3, & 4	46,800	12,700	3,900	63,400	61,500	1.0:1
Total	46,800	12,700	3,900	63,400	61,500	1.0:1

1/ Adjusted normalized prices

Table 7, Land treatment for watershed protection and development, Santa Fe River Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Total acres	Total treatment completed	Total acres remaining	Total needs
1. Grassland	101,835			
1a-Snowpack mgt.	205		205	20
1c-Good range mgt.	91,096		91,096	91,096
2. Grazable woodland	30,822			
2a-Pinyon-juniper cont.	11,622		11,622	11,622
2b-Pinyon-juniper mgt.	19,200		19,200	19,200
3. Brushland				
3b1-Chaparral control	1,587		1,587	1,587
4. Commercial timber	18,073			
4a-Spruce-fir mgt.	5,990		5,990	900
4b-Ponderosa pine mgt.	11,929		11,929	1,100
4c-Aspen mgt.	154		154	0
5. Bottomland				
6. Crop, pasture, hayland	1,333			
6a-Irrigated land	360			
6a2-Improved irrigation	360	180	180	180
6c-Abandoned cropland	973		973	300
7. Miscellaneous land	10,650			
8. Critical erosion area	10,534	716	9,818	9,818

Table 8, Land treatment needs and impacts (1969-1980), Santa Fe River Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Needs treatment (acres)	Total treatment cost $	Impacts - average annual values: Water $	Sediment reduction $	Red meat $	Timber wood $	Cultivated land $	Increased net income $	Employment man-years
1. Grassland									
1b-Snowpack mgt.	20	1,700	88	2,088				2,176	.1
1c-Good range mgt.	91,096	45,548			40,995			40,995	3.4
2. Woodland									
2a-Pinyon-juniper cont.	11,622	197,574		1,174	10,458			11,632	14.8
2b-Pinyon-juniper mgt.	19,200	192,000		2,382	12,096			14,478	14.4
3. Brushland									
3b2-Chaparral mgt.	1,587	11,902		191	1,782			1,973	.9
4. Commerical timber									
4a-Spruce-fir mgt.	900	36,000	3,300	51	1,008	3,555		7,914	2.7
4b-Ponderosa pine mgt.	1,100	33,000	1,008	51	1,242	4,235		6,436	2.6
5. Bottomland									
6. Cultivated									
6a-Irrigated land									
6a2-Improved irrigation	180	19,800					13,500	13,500	1.5
6c-Abandoned cropland mgt.	300	4,500		3	2,700			2,703	.3
7. Miscellaneous									
8. Critical erosion area	9,818	147,270		1,174	22,086			23,260	11.0

LEGEND

◀	FLOODWATER RETARD STR.
②	SITE NUMBER
1b	SNOW PACK MGT.
1c	GOOD RANGE MGT.
2a	PINYON-JUNIPER CONTROL
2b	PINYON-JUNIPER MGT.
3-2	CHAPARRAL CONTROL & MGT.
4a	SPRUCE FIR MGT.
4b	PONDEROSA PINE MGT.
4c	ASPEN MGT.
6a	IRRIGATED LAND MGT.
6c	ABANDONED CROPLAND MGT.
7	MISCELLANEOUS LAND
8	CRITICAL EROSION AREAS

STRUCTURE LOCATION AND LAND TREATMENT MAP

SANTA FE RIVER WATERSHED
UPPER RIO GRANDE BASIN

APPROX. SCALE 1:140,000

1969

GALISTEO CREEK WATERSHED
Upper Rio Grande Basin
Santa Fe and Sandoval Counties
CNI 1-139

The Watershed in Brief

The watershed is located about 30 miles north of Albuquerque. The total drainage area of the Galisteo Creek Watershed is 710 square miles which is divided into three watersheds in the conservation needs inventory. Of this total drainage area 596 square miles will be controlled by a floodwater retarding structure, Galisteo Dam, which is under construction by the Army Corps of Engineers. This structure was authorized by Public Law 645 in 1960, and will control downstream damages caused by the Galisteo Creek. The structure is located in the middle of CNI watershed 1-139.

The drainage area of CNI 1-139 is 172,589 acres, or about 270 square miles, and is tributary to the Rio Grande. About 112,407 acres are private land, 18,250 acres are state land, and 16,972 acres are federal land, and 24,960 acres are Indian land.

The area which has a flood problem is only a portion of the total Galisteo drainage area and is located in the vicinity of Pena Blanca. The drainage area contributing to the flood problem is about four square miles.

Sea level elevations range from about 5,200 feet at the confluence of the Galisteo Creek with the Rio Grande, to about 10,500 feet in the Sangre de Cristo Mountains. The arroyos within the Galisteo Watershed drain to the west.

About 171,129 acres of the area are devoted to livestock production and 1,460 acres are used for irrigated cropland. The irrigated land is used mainly for the production of alfalfa and small grains. There are three communities within the watershed: Pena Blanca, Santo Domingo Pueblo, and Domingo.

The Atchison Topeka and Santa Fe Railroad traverses the watershed. State Highway 22 and U. S. Highway 85 service communities within the watershed. (See figure 1 for more details).

The average annual precipitation is less than 8 inches at Pena Blanca. The average annual temperature is about 49 degrees Fahrenheit, with a low of 15 degrees below zero and a high of 98 degrees Fahrenheit. The evaporation rate is high.

The watershed is within the Four-Corners Economic Development Region.

Watershed Problems and Needs

The primary problem of this watershed is damage from floodwater and sediment in the village of Pena Blanca and to the irrigated cropland, canals and ditches. High intensity summer thunderstorms swell arroyos with floodwater which flows through Pena Blanca damaging homes, businesses, yards, and irrigation facilities. Irrigation canals are filled with

sediment and canals are broken by floodwater. These events ordinarily occur at the time of year when plant water requirements are highest. Interruption of service to irrigated land results in lost crops and reduced yields. On the two sites mentioned in this report, there are no definite channels to the river. Any floodwater that cannot be handled by the irrigation canal damages irrigated land below.

To cope with these problems a comprehensive combined land treatment and structural measure program is needed.

Physical Potential for Meeting Needs

The average annual precipitation is about 8 inches and the evaporation rate is high. For this reason, any permanent storage of water is not considered feasible in the structures proposed. There are, however, many opportunities for building picnic and camping grounds along the Rio Grande channel.

The topography of the area lends itself very well to the installation of small floodwater retarding structures. The two structures proposed in this report are felt to be the least costly and will meet the needs. There are, however, other possible alternate structure sites.

There are no channels from the Cochiti Main Canal to the river. A system of outleting the principal spillway flow is to utilize the canal to a point where the flow can be outleted into a natural channel to the river.

The soil material available at the proposed structure sites has good construction qualities and will not present any problems for construction of a standard retarding structure. There is a sufficient quantity of the soil material in the immediate vicinity of each structure site to provide the needed fill for construction of the dams and needed channel.

Geologically the two sites are in the Santa Fe Group. There should be no problems with borrow or foundation at either site. The permeability in the channels and abutments will be checked before final design. Depth to cutoff(Santa Fe Group) in the channel may be as much as 30 feet.

Local Interest in Project Development

At the present time, local interest in a flood prevention project is low. This lack of interest may be due to the people's confidence in several small flood control structures installed about ten years ago. It appears that these structures are short lived and under-sized for the degree of protection needed for the residential areas. Local interest and the need for a higher degree of protection may not be generated until damages actually occur sometime in the future. An organization with legal authorities to sponsor Public Law 566 program would have to be established but at the present time there may be strong opposition to an organization of this type.

Works of Improvement for Potential Development

Land Treatment

The most important land treatment system needed is good range management on all grazing land. Much of the watershed area has been subjected to overstocking. The Santo Domingo Pueblo land and the breaks along the Rio Grande and Galisteo Creek are critical erosion areas and need special methods to reduce erosion and restore the area to productive use. The treatment system includes the proper combination of the following practices: livestock exclusion or limited livestock use, small gully control, water spreading devices, grazing land mechanical treatment, fencing, intensive vegetation management (pinyon-juniper and brush control) and critical area seeding.

There are several old mining areas that need special revegetation programs to restore their potential as range or recreation and beautification areas. The area of Madrid is an example.

Approximately 30 percent of the pinyon-juniper woodland occupies moderately deep soils on slopes less than 15 percent. These areas are adaptable to pinyon-juniper clearing. About 1,250 acres of bottomland vegetation need treatment. All but 20 acres of the recommended treatment can be accomplished in conjunction with a drainage program along the Rio Grande. The result will be an increase in the acreage of productive cropland. Twenty acres need to be managed for recreation, wildlife protection, and streambank protection. A drainage program designed to lower the water table would allow farmers a wide selection of adaptable crops, and permit reclamation of several fields that have detrimental salt accumulation. Improved irrigation practices need to be initiated on approximately 85 percent of the irrigated land to insure good irrigation water management. This can be accomplished under Public Law 46 programs. (See tables 7 and 8 and figure 1).

Structural Measures

From a reconnaissance of the watershed, two sites just east of Pena Blanca were selected that are suitable for providing flood protection to the town and to the agricultural land west of town. These structures will be single purpose flood control structures.

A proposed outlet for the principal spillway discharge for both sites is to empty into the Cochiti Main Canal which will convey the water about one mile and outlet it into an existing channel to the river. This will require (1) two small structures into the canal, (2) enlarging the canal to accommodate the increased flow, and (3) a structure to control and outlet the floodwater to the river. For location of the proposed structural measures see figure 1.

The two structures proposed on arroyos at Pena Blanca would be designed to store the 100-year sediment yield and the flood runoff from a one-percent storm. The sites are high-hazard, class "c" sites.

Nature and Estimate of Costs of Improvement

The structural data, capacities and quantities were developed after a field reconnaissance of the sites using U. S. Geological Survey 1:24,000 quadrangle maps. The canal enlargement and outlet structures are planned to discharge the flows from the principal spillway and from the area between the dam and the canal. (See tables 1 and 2 for detailed structure data).

The cost of the earthfill structures is based on a unit cost per cubic yard for the dam installation. The unit cost for earthwork was obtained from a data cost curve developed from costs and quantities from Public Law 566 watershed work plans where a detailed cost estimate has been made on structures of similar nature in New Mexico. The cost of the outlet channel is based on a unit cost per cubic yard of concrete for a size and type of structure suitable to control the flow. The unit cost is the current cost of reinforced concrete in the area. The unit cost used in estimating the cost of enlarging the canal is a value arrived at on the judgment of the engineer making the estimates.

The total cost of the proposed structural measures is estimated to be $123,900, of which $118,700 is federal cost and $5,200 is local cost. These costs are distributed in accordance with current provisions of Public Law 566.

The average annual cost is $6,500 of which $6,100 is for installation and $400 is for operation and maintenance of the structures. (See table 5).

Effects and Economic Feasibility of Potential Development

Pena Blanca is a small community located immediately below two small arroyos where a potential flood hazard exists. Projections for future home and business construction indicate there will be thirty to forty units subject to flood damage. The future flood hazard will be increased when existing small sediment structures are filled or fail due to an intensive storm. The farmland below Pena Blanca is used for alfalfa, row crops, and orchards. The area subject to damage is about 200 acres.

Average annual floodwater damages to urban and agricultural improvements amounts to $6,900. It is estimated that the damage area will receive approximately 100 percent reduction in damages. This will result in $6,900 in average annual damage reduction benefits. Other project benefits accruing to structural measures include redevelopment benefits in the amount of $1,300 and secondary benefits in the amount of $600. Total project benefits are estimated to be $8,800 and when compared to average annual cost of $6,500 will provide a benefit-cost ratio of 1.4 to 1. (See tables 4, 5, and 6).

Table 1, Structure data, Galisteo Creek Watershed, Upper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Estimated height of dam (feet)	Estimated volume of fill (cu.yd.)	Principal spillway: Type	Principal spillway: Release rate (csm)	Emergency spillway: Type	Emergency spillway: % chance of use	Max. surface area, emergency spwy. level (acres)
1	0.8	23	42,253	RC conduit	20	earth	1	16
2	0.5	24	24,892	RC conduit	20	earth	1	11

Table 2, Reservoir storage capacity, Galisteo Creek Watershed, UPper Rio Grande Basin, New Mexico

Site number	Drainage area (sq.mi.)	Storage capacity (acre-feet): Sediment	Storage capacity (acre-feet): Detention	Storage capacity (acre-feet): Total flood prevention	Additional storage cap. available (acre-feet)	Sediment storage rate 1/ (ac.ft./sq.mi./yr.)
1	0.8	60	43	103	-	0.75
2	0.5	41	27	68	-	0.82

1/ Erosion rates in the watershed range up to 1.0 acre-feet per square mile per year.

Table 3, Distribution of structural cost-potential development, Galisteo Creek Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Installation cost				
	Construction	Installation services	Land, easements and r. w.	Administration of contracts	Installation cost
Floodwater retarding structure, site 1	45,000	15,000	2,500	200	62,700
Floodwater retarding structure, site 2	34,000	11,000	2,000	200	47,200
Outlet works sites 1 and 2	11,000	2,700	100	200	14,000
Total	90,000	28,700	4,600	600	123,900

1/ Price base: 1969

Table 4, Estimated average annual flood damage reduction benefits, Galisteo Creek Watershed, Upper Rio Grande Basin (dollars) 1/

Item	Estimated average annual damage: Without project	Estimated average annual damage: With project	Damage reduction benefits
Floodwater			
Urban	4,300	-	4,300
Agricultural	2,000	-	2,000
Subtotal	6,300	-	6,300
Indirect	600	-	600
Total	6,900	-	6,900

1/ Based on adjusted normalized prices

Table 5, Annual cost, Galisteo Creek Watershed, Upper Rio Grande Basin, New Mexico

Evaluation unit	Amortization of installation cost (dollars) 1/	Operation and maintenance cost (dollars) 2/	Total annual cost
Floodwater retarding structures sites 1, 2, and outlet works	6,100	400	6,500
Total	6,100	400	6,500

1/ Amortized at 4 7/8 percent interest for 100 years
2/ Based on adjusted normalized prices

Table 6, Comparison of benefits and costs for structural measures, Galisteo Creek Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Evaluation unit	Average annual benefits: Flood prevention damage reduction	Redevelopment	Secondary	Total	Average annual cost	Benefit-cost ratio
FRS sites 1, 2, & outlet works	6,900	1,300	600	8,800	6,500	1.4:1
Total	6,900	1,300	600	8,800	6,500	1.4:1

1/ Adjusted normalized prices

Table 7, Land Treatment for watershed protection and development, Galisteo Creek Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Total acres	Total treatment completed	Total acres remaining	Total needs
1. Grassland				
1b-Snowpack mgt.				
1c-Good range mgt.	72,808			72,808
2. Grazable woodland				
2a-Pinyon-juniper control	16,914	100	16,814	16,814
2b-Pinyon-juniper mgt.	46,714			46,714
3. Brushland				
4. Commercial timber				
5. Bottomland				
5a-Phreatophyte control	1,234	75	1,159	1,159
5b-Bottomland mgt.	20			20
6. Crop, pasture, hayland				
6a-Irrigated land	1,460			
6a1-Drainage	1,460		1,460	1,460
6a2-Improved irrigation	1,340	200	1,140	1,140
7. Miscellaneous land	60			
8. Critical erosion area	23,608		23,608	23,608

Table 8, Land treatment needs and impacts (1969-1980), Galisteo Creek Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Needs treatment (acres)	Total treatment cost $	Impacts - average annual values: Water $	Sediment reduction $	Red Meat $	Cultivated land $	Increased net $ income	Employment man-years
1. Grassland								
1b-Snowpack mgt.								
1c-Good range mgt.	72,808	36,404		1,727	32,760		34,487	2.7
2. Woodland								
2a-Pinyon-juniper cont.	16,814	287,538		1,772	15,219		16,991	21.6
2b-Pinyon-juniper mgt.	46,714	467,140		6,006	28,026		34,032	35.0
3. Brushland								
4. Commercial timber								
5. Bottomland								
5a-Phreatophyte cont.	1,234	37,020	40,722		11,106		51,828	2.8
5b-Bottomland mgt.	20	200			45		45	
6. Cultivated land								
6a-Irrigated								
6a1-Drainage	1,510	30,200				113,250	113,250	2.2
6a2-Improved irrigation	1,340	147,400				100,500	100,500	11.1
7. Miscellaneous								
8. Critical erosion area	23,608	35,412		7,011	53,118		60,129	2.7

LEGEND

- FLOODWATER RETARD STR.
- (2) SITE NUMBER
- 1c GOOD RANGE MGT.
- 2a PINYON-JUNIPER CONTROL
- 2b PINYON-JUNIPER MGT.
- 5 BOTTOMLAND VEGETATION MGT.
- 6a IRRIGATED LAND MGT.
- 8 CRITICAL EROSION AREA

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

GALISTEO CREEK WATERSHED
UPPER RIO GRANDE BASIN

APPROX. SCALE 1:140,000

1969

ESPANOLA-RIO CHAMA WATERSHED
Upper Rio Grande Basin
Rio Arriba County, New Mexico
CNI 1-C2
CNI 1-148

The Watershed in Brief

The watershed includes an area of about 147,380 acres (230.28 square miles) in Rio Arriba County. Approximately 22 percent of the land area is privately owned, 1 percent is state owned, 70 percent is federal, and 7 percent is Indian land.

The watershed includes the Guachupangue Arroyo just south of Espanola New Mexico and extends northwesterly along the southside of the Rio Chama to about 5 miles west of Abiquiu. The major portion of the watershed drains into the Rio Chama which is a tributary to the Rio Grande. The area around Espanola drains directly into the Rio Grande.

The watershed is in the southern part of the Southern Rocky Mountains Physiographic Province. Elevations range from about 5,500 feet in the valley bottom to about 11,500 feet on Santa Clara Peak. The higher elevations are in the Southern Rocky Mountain Land Resource Area, and most of the lower elevations are in the New Mexico, Arizona Plateaus and Mesas Land Resource Area.

Average annual precipitation ranges from about 9 inches in the valley to about 30 inches in the mountains.

The principal land use is for grazing of livestock with about 2,600 acres of irrigated land serviced by 17 separate irrigation systems.

This acreage is divided into about 750 farming units with the major crops being orchards, truck crops, chili, and alfalfa. The present value of the irrigated cropland is about $1,000 per acre.

The watershed is in the Northern Rio Grande Resource Conservation and Development area. Improvement is being made on some of the irrigation systems under this program. Also, the Duke City Lumber Company has installed a large sawmill near Espanola as a result of the RC&D program. Rio Arriba County is within the Four-Corners Economic Development Region.

Several small villages are within the watershed boundaries and homes are scattered throughout the floodplain area. The city of Espanola, with a population of about 5,000 people, is within the watershed. Total population of the watershed is about 7,000. A major U. S. Highway, U. S. 84, traverses the lower part of the watershed.

Watershed Problems and Needs

Watershed problems were discussed with individual landowners. They agree that the primary flood problem and damage is sediment deposition on farm land and in their irrigation ditches. Arroyo aggradation, due to sediment deposition, has resulted in reduced channel capacities which causes flooding and sediment deposition on adjacent farmland. Many of the arroyos do not have a channel to the river but terminate at the irrigation ditch which is a major factor causing sediment deposition in the system. The sediment in the system disrupts irrigation services. This lowers crop yield and, in some cases, has resulted in complete crop loss.

Delays of traffic from the combined sediment and washed out bridges on U. S. Highway 84 have occurred. Highway culverts are frequently plugged with sediment.

Sediment deposited in the Rio Chama is reducing the channel capacity and raising the water table under some adjacent cropland.

Floods are generally caused from local high intensity thunderstorms which normally occur during the months of June through September. Floods cause damages to the irrigated cropland, irrigation systems, residential and business properties in the villages and the city of Espanola. Damage to U. S. Highway 84 has also occurred.

Sediment source area northwest of Espanola on Lovato Grant (Soil Conservation Service photograph

Damaging floods usually occur annually on one or more of the arroyos. They have been reported in 1910, 1941, 1950, 1952, 1957, 1961, 1962, 1963, 1964, and 1966. A storm that occurred over the Plaza Largo drainage in 1910 was reported to have caused a flood that inundated 300 acres of farmland. The water was estimated to have reached a maximum depth of 8 feet. A synthetic analysis of runoff indicates this is about a one-percent chance of occurrence storm.

Parts of the watershed are critical erosion areas. One 112 acre area near Chili had a gross sediment production rate of 5.4 acre-feet per square mile per year during the summer of 1964. Other areas where the Santa Fe Formation is the predominant geologic formation also have severe erosion.

Between 85 percent and a full supply of irrigation water is available from the Rio Chama. Many of the irrigation systems are inefficient and unable to adequately serve the irrigated areas.

There are about 400 acres of cropland involving six landowners which have a highwater table and need to be drained to return the land to full productivity. Part of this problem may be solved by reducing sediments entering the river. This would cause some of the sediment in the river bottom to be removed by scour.

Physical Potential for Meeting Needs

There is an adequate number of suitable sites where floodwater retarding dams can be constructed. Each of the possible sites will carry a high-hazard classification. There is also a possible site for a multiple purpose or recreation structure in the Abiquiu Creek Drainage.

Both surface flow and groundwater are of suitable quality for any type of irrigated crops.

Many of the arroyos do not have adequate channels from the base of the hills to the irrigation canals. These channels end at the canal with no outlet to the river. This condition contributes much to the damage caused by floods. To provide adequate flood protection to the area, channels to the river will have to be constructed.

Suitable conditions and materials are present to initiate and complete a major land treatment program. There should be at least temporary exclusion of livestock with a possible seeding program and an intensive program of installing gully plugs and grade stabilization structures in the upper reaches of the watershed.

Reorganization and rehabilitation of the irrigation systems can be carried out with very little, if any, additional requirements for rights-or-way. At present some systems are being improved under the Resource Conservation and Development program.

The soils in the area needing drainage are such that drains would function adequately to lower the water table. However, a gravity outlet may not be available to the river and a pump station may have to be considered for an outlet to a subsurface drainage system.

Local Interest in Project Development

The local people are interested in conservation and land treatment measures. About 65 percent of the land is under agreement with the local soil and water conservation district. It is also estimated that about 30 percent of the needed land treatment measures on private lands have been installed.

In June 1963, an application for assistance under Public Law 566 was submitted with the Abiquiu-Vallecitos and Espanola Soil and Water Conservation Districts (now combined into the East Rio Arriba Soil and Water Conservation District), the City Council of Espanola, and the Rio Arriba County Commission as co-sponsors.

In September 1964, the watershed planning staff of the Soil Conservation Service made a preliminary investigation of the watershed and reported that a project was needed and could be justified under the provisions of Public Law 566. The watershed has been authorized for planning of flood protection works under PL 566 with planning surveys and investigations in progress to prepare a watershed work plan. With the City of Espanola and the Rio Arriba County Commission as co-sponsors of the project, the legal needs of a project sponsorship are adequate.

Hybrid sweet corn having from 2 to 3 ears per stalk sold as a cash crop. Farmer, Lester Whitney (Soil Conservation Service photograph).

SCS PHOTO 12-P362-16

Local sponsors have indicated a willingness and a financial ability to assume their share of project costs. These costs will include obtaining easements and rights-of-way and performing necessary operation and maintenance of structural measures.

Works of Improvement for Potential Development

Land Treatment

About 60,000 acres of grassland and pinyon-juniper woodland are considered critical erosion areas. Treatment will include exclusion or limited livestock use, small gully control, water-spreading devices, grazing land mechanical treatment, and seeding of adapted grass and browse species. Soil, climatic and topographic conditions combine to make land treatment difficult in the lower reaches of this watershed. Areas of badland and deep sands should be treated to keep the materials eroding from them as close to the source as possible. Small gully plugs, net wire fences, contour furrows, diversions, vertical slat fence for wind erosion and seeding treated areas are a few of the practices that appear to merit consideration by land planners.

Grazing management is needed on all areas of the watershed. Most of the grazing land below the ponderosa pine line is suffering from overuse. Grazing systems including deferred grazing, rotation deferred grazing, and better livestock distribution by fencing and livestock watering facilities are the main practices. (See tables 4 and 5, and figure 1 for more detail on land treatment).

Structural Measures

A reconnaissance of the floodplains was made and a determination made that many of the arroyos were causing damage to the developed areas. In two locations three arroyos are causing damage to the same area. Floodwater retarding structures are proposed on 14 of these arroyos controlling 42.8 square miles of drainage area. (See table 1 and figure 1). It may be possible when detailed studies are made, that other structures can be justified. An outlet channel to the river for principal spillway discharge will have to be constructed for each site. This will require about 4 miles of channel. Foundation conditions and available fill material present no major construction problems; however, fill material will generally be a poorly-graded sandy material.

Inverted siphons or floodwater overshots will be needed at 19 locations to cross existing irrigation ditch systems.

A possible structure location for a recreation reservoir on Abiquiu Creek about 5 miles south of the Town of Abiquiu was recognized but is not included in the watershed project.

A recreation reservoir is also possible on the Rio del Oso about 1 mile below the San Lorenzo Spring. Another possible site for recreation

reservoir on the Rio del Oso is about 3 miles west of the San Lorenzo Spring at an abandoned sawmill site. These possibilities are not included in the watershed project. These are shown on the watershed map as multi-purpose structures, sites 15, 16, and 17.

Nature and Estimate of Costs of Improvements

From a field reconnaissance, use of U. S. Geological Survey 7 1/2 minute quad maps, and aerial photos of the area, it was determined that a possible site exists at the needed locations. The drainage area above each proposed floodwater retarding structure was determined from the quad maps. Cost estimates of the structures were calculated using a graph developed from cost estimates developed during planning the nearby Sebastian Martin-Black Mesa Watershed. All structures are classified as high-hazard structures.

For this report, it is assumed that the reorganization and rehabilitation of irrigation facilities is justified so no estimate of cost nor types and quantities of structural measures have been made.

Effects and Economic Feasibility of Potential Development

Of the total average annual cost of $118,200, the operation and maintenance cost is $4,600 and amortized installation cost is $113,600. The estimated average annual project benefits are $201,100, giving a benefit-cost ratio of 1.7:1 (See table 2).

Inasmuch as planning under Public Law 566 for a flood protection project is in progress, the estimated average annual flood damage reduction benefits are not presented in this report. The PL 566 watershed work plan will contain these details.

Table 1, Estimated structural cost distribution, Espanola-Rio Chama Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structural measures	Federal cost: Construction	Federal cost: Installation	Federal cost: Total	Other costs: Land rights	Other costs: Contr. Adm.	Other costs: Total	Total cost
Floodwater retarding structures 2/							
Sites 1 & 2	207,020	110,000	317,020	13,550	400	13,950	330,970
Sites 3, 4, & 5	317,660	170,280	487,940	20,490	600	21,090	509,030
Site 6	366,620	197,440	564,060	9,220	300	9,520	573,580
Site 7	20,900	11,330	32,230	2,100	200	2,300	34,530
Site 8	71,260	38,230	109,490	1,600	200	1,800	111,290
Sites 9, 10, & 11	206,380	110,640	317,020	4,550	600	5,150	322,170
Sites 12, 13, & 14	321,800	172,440	494,240	3,990	700	4,690	498,930
Total	1,511,640	810,360	2,322,000	55,500	3,000	58,500	2,380,500

1/ Price base 1969
2/ Includes cost of 4 miles of channels

Table 2, Comparison of benefits and costs of structural measures, Espanola-Rio Chama Watershed, Upper Rio Grande Basin, New Mexico

Structures	Amortization of installation cost 1/ (dollars)	Aver. annual operation & maintenance cost 2/ (dollars)	Average annual cost (dollars)	Estimated av. annual benefits (dollars)	Benefit-cost ratio
Sites 1 & 2	15,800	900	16,700	11,200	0.7:1
Sites 3, 4, & 5	24,300	800	25,100	37,500	1.5:1
Site 6	27,400	700	28,100	29,200	1.0:1
Site 7	1,600	100	1,700	4,400	2.6:1
Site 8	5,300	300	5,600	14,100	2.5:1
Sites 9, 10, & 11	15,400	900	16,300	31,700	1.9:1
Sites 12, 13, & 14	23,800	900	24,700	73,000	3.0:1
Total	113,600	4,600	118,200	201,100	1.7:1

1/ Amortized at 4 7/8 percent interest for 100 years.

2/ Adjusted normalized prices.

Table 3, Land treatment for watershed protection and development, Espanola-Rio Chama Watershed, Upper Rio Grande Basin, New Mexico.

Land treatment system	Total acres	Total treatment completed	Total acres remaining	Total needs
1. Grassland				
1b-Snowpack mgt.	300		300	
1c-Good range mgt.	28,819			28,819
2. Grazable woodland				
2a-Pinyon-juniper cont.	12,902	1,700	11,202	11,202
2b-Pinyon-juniper mgt.	9,820			9,820
3. Brushland				
3a1-Chaparral control	916		916	200
3b1-Chaparral mgt.	1,000			1,000
4. Commercial timber				
4a-Spruce-fir mgt.	5,708		5,708	850
4b-Ponderosa pine mgt.	16,384	500	15,884	1,588
4c-Aspen mgt.	2,903		2,903	
5. Bottomland				
5a-Phreatophyte control	2,718	200	2,518	2,518
5b-Bottomland mgt.	200			200
6. Crop, pasture, hayland				
6a-Irrigated land	2,992			
6a1-Drainage	1,500	100	1,400	1,400
6a2-Improved irrigation	2,500	600	1,900	1,900
6b-Dryland	340		340	340
6c-Abandoned cropland	310		310	310
7. Miscellaneous land	1,100			
8. Critical erosion area	59,968	1,500	58,458	58,458

Table 4, Land treatment needs and impacts (1969-1980), Espanola-Rio Chama Watershed, Upper Rio Grande Basin, New Mexico

Land treatment system	Needs treatment (acres)	Total treatment cost $	Impacts-average annual values: Water $	Sediment reduction $	Red meat $	Timber wood $	Cultivated land $	Increased net income $	Employment man-years
1. Grassland									
1b-Snowpack mgt.									
1c-Good range mgt.	28,810	14,409		632	12,969			13,601	1.1
2. Woodland									
2a-Pinyon-juniper control	11,202	190,434		1,084	10,080			11,128	14.3
2b-Pinyon-juniper mgt.	9,820	98,200		1,163	5,895			7,058	7.4
3. Brushland									
3a1-Chaparral control	200	2,400		23	450			473	.2
3b1-Chaparral mgt.	1,000	15,000	4,583	113	2,250			6,946	1.2
4. Commercial timber									
4a-Spruce-fir mgt.	850	34,000	3,117	34	954	3,358		7,463	2.6
4b-Ponderosa pine mgt.	1,588	47,640	1,456	68	1,782	6,114		9,420	3.6
5. Bottomland									
5a-Phreatophyte control	2,518	75,540	83,094		22,662			105,756	5.6
5b-Bottomland mgt.	200	2,000			450			450	.2
6. Cultivated									
6a-Irrigated land									
6a1-Drainage	1,400	28,000					105,000	105,000	2.1
6a2-Improved irrigation	1,900	209,000					142,500	142,500	15.7
6b-Dryland	340	6,800		5			1,190	1,195	.5
6c-Abandoned cropland	310	4,650		3	2,790			2,793	.3
7. Miscellaneous									
8. Critical erosion area	58,468	877,020		6,600	131,553			138,153	65.7

LEGEND

◁	FLOOD RETARD STR.
	MULTI PURPOSE STR.
②	SITE NUMBER
1c	GOOD RANGE MGT.
2a	PINYON-JUNIPER CONTROL
2b	PINYON-JUNIPER MGT.
3-2	CHAPARRAL COTROL & MGT.
4a	SPRUCE-FIR MGT.
4b	PONDEROSA PINE MGT.
4c	ASPEN MGT.
5	BOTTOMLAND VEGETATION MGT.
6a	IRRIGATED LAND MGT.
6c	ABANDONED CROPLAND MGT.
7	MISCELLANEOUS LAND
8	CRITICAL EROSION AREA

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

ESPANOLA RIO CHAMA WATERSHED
UPPER RIO GRANDE BASIN

SCALE 1"= 2 MI.

APPROX. SCALE 1:125,000

1969

SEBASTIAN MARTIN-BLACK MESA WATERSHED WORK PLAN SUMMARY
Upper Rio Grande Basin
Rio Arriba County, New Mexico
CNI 1-150

The Watershed in Brief

The work plan for watershed protection and flood prevention for Sebastian Martin-Black Mesa Watershed, New Mexico, has been prepared by the East Rio Arriba Soil and Water Conservation District and the Upper Rio Grande Watershed District, the sponsoring organizations. Technical assistance was provided by the Soil Conservation Service and the Forest Service of the United States Department of Agriculture and the Bureau of Land Management of the Department of Interior.

The watershed covers an area of 161 square miles or 103,040 acres in Rio Arriba County, New Mexico. The south boundary of the watershed is north of Espanola, New Mexico, and the north boundary is just north of Velarde, New Mexico. There are several small communities within the watershed but Espanola is the main trading center.

The major land uses are 91.7 percent rangeland, 7.7 percent irrigated cropland, and 0.6 percent miscellaneous uses. Miscellaneous uses include roads, highways, irrigation canals, and farmsteads.

About 63.4 percent of the watershed area is federal land of which 43.8 percent is administered by the Bureau of Land Management and 19.6 is administered by the Forest Service. About 25.7 percent of the land is private and state land, and 10.9 is Indian land.

The Llano Unit of the San Juan-Chama Project of the Bureau of Reclamation will bring about changed land use of 2,118 acres, from rangeland to irrigated cropland.

Watershed Problems and Needs

Recent damaging floods were reported in 1958, 1961, and 1964. Floodwater and sediment damage to irrigation facilities causing interrupted irrigation services to about 8,000 acres of irrigated land is a major problem. Floods damage irrigated land, residences, businesses and highways. There is a great need for flood protection measures and watershed protection. This can be accomplished with the installation of land treatment measures and floodwater retarding structures.

The watershed is within the Four-Corners Economic Development Region and within the Northern Rio Grande Resource Conservation and Development Project.

Local Interest in Project Development

In 1959 the local interests submitted an application for flood protection assistance under Public Law 566. Since that time the watershed has been authorized for planning assistance and the work plan completed.

The local people have formed a watershed district in accordance with the Watershed District Act of New Mexico. The Upper Rio Grande Watershed District has the powers of taxation and eminent domain. Collection of taxes was started in 1968 for the project.

Land easements and rights-of-way have been cleared on several of the structure sites. The watershed district with assistance from the East Rio Arriba Soil and Water Conservation District will obtain land, easements and rights-of-way. The watershed district will perform the necessary operation and maintenance for structural measures. District funds are considered sufficient for this purpose.

Works of Improvement for Potential Development

Purpose

The primary purpose of the watershed project is to reduce flood damages to irrigated cropland, roads, highways, irrigation structures, canals and ditches, farmsteads, and urban areas.

The work plan proposes a 5-year period for installing the needed works of improvement at a total estimated cost of $3,350,732. The share of this cost to be borne by other than Public Law 566 funds will be $880,273 and the Public Law 566 share will be $2,470,459.

Sediment from Rio de Truchas entering the Rio Grande (Soil Conservation Service photograph) SCS PHOTO 12-P261-9

High sediment producing area west side of Rio Grande (Soil Conservation Service photograph)

SCS PHOTO 12-P240-10

Flood damage near Velarde School (Soil Conservation Service photograph)

SCS PHOTO 12-P457-14

Land Treatment

Land treatment measures will be established within the watershed by the landowners and operators of private and state land and by the Forest Service and Bureau of Land Management on federal land. These measures will be applied during the 5-year project installation period. Land treatment will consist of those measures which will provide necessary conservation development and improvement of individual land ownerships, and federal land administered by the Bureau of Land Management and the Forest Service. Land treatment measures for recreational purposes are also included in the plan.

The cost for land treatment measures for the 5-year period is estimated to be $897,008 of which $852,449 will be borne by other than Public Law 566 funds. Public Law 566 funds amounting to $44,559 will be used for technical assistance to accelerate the application of land treatment measures. PL 566 funds are necessary in order to install land treatment within the 5-year project installation period (table 1). The Forest Service will request supplemental funds of $43,975 for installation of land treatment on Forest land. Total land treatment needed by 1980 is reflected in tables 8 and 9 and on figure 1.

Structural Measures

The structural measures included in the plan consist of 13 floodwater retarding structures with appurtenances and one floodwater diversion. The structures will have an aggregate capacity of 6,252 acre-feet of floodwater detention and sediment storage. The total cost of structural measures is $2,453,724, of which the local share is $27,824 and Public Law 566 share is $2,425,900 (table 2).

Operation and Maintenance

The land treatment measures will be maintained by the landowners and operators of the farms and ranches on which the measures are installed under agreements with the East Rio Arriba Soil and Water Conservation District. The Forest Service and the Bureau of Land Management will maintain the land treatment on land administered by them.

Pursuant to the provisions of Public Law 566, operation and maintenance of the 13 floodwater retarding structures with appurtenances and the floodwater diversion will be obligations of the Upper Rio Grande Watershed District. The estimated average annual cost of operation and maintenance of the works in the watershed work plan is $6,048.

Effects and Economic Feasibility of Potential Development

The average annual flood damages under future development without project are estimated to be $174,052. This includes direct average annual floodwater damage of $60,134, direct average annual sediment damage of $97,965, and average annual indirect damage of $15,953. Flood damage to agricultural property constituted approximately 97 percent of annual flood damages, the remaining 3 percent representing damage to non-agricultural property.

Estimated average annual flood damages remaining with the project in place are $34,992, of which $9,713 are floodwater damages, $21,976 are sediment damages, and $3,303 are indirect damages. This represents a reduction in floodwater damage of 84 percent and a reduction in sediment damage of 78 percent.

The average annual primary benefits accruing to structural measures are $137,205, which are distributed as follows:

Floodwater damage reduction	- $ 50,421
Sediment damage reduction	- 74,150
Indirect damage reduction	- 12,466
Changed land use	- 168
Total	- $137,205

Processors for agricultural commodities and other businesses in the area will benefit from the project. Secondary benefits of $12,475 stemming from the project will result. Opportunity for additional employment of the unemployed and underemployed segment of the local population will be provided by the project, producing redevelopment benefits of $15,184.

The ratio of the total average annual benefits accruing to structural measures, $164,869 to the average annual cost of structural measures, $120,784, is 1.4 to 1 (table 7).

Approximately 300 farms and 4,800 acres of irrigated cropland will be directly benefited by the project. The project will also provide flood protection to irrigation facilities, farmsteads, roads, highways, and residential areas.

The conservation benefits of land treatment measures were not evaluated. Flood reduction benefits downstream on the Rio Grande were not evaluated.

Table 1, Estimated Project Installation Cost, Sebastian Martin-Black Mesa Watershed, El Rio Arriba Subbasin, Upper Rio Grande Basin, New Mexico

Installation Cost Item	Unit	Number to be Applied: Federal land	Number to be Applied: Non Federal Land	Number to be Applied: Total	Estimated Cost (Dollars)1/: Public Law 566 Funds: Federal Land	Public Law 566 Funds: Non Federal Land	Public Law 566 Funds: Total	Other Funds: Federal Land	Other Funds: Non Federal Land	Other Funds: Total	Total
LAND TREATMENT											
Soil Conservation Service											
Cropland	Acres	-	3,410	3,410	-	-	-	-	300,640	300,640	300,640
Rangeland	Acres	-	15,531	15,531	-	-	-	-	109,024	109,024	109,024
Recreation	Acres	-	200	200	-	-	-	-	20,690	20,690	20,690
Technical Assistance		-	-	-	-	44,559	44,559	-	41,938	41,938	86,497
SCS Subtotal					-	44,559	44,559	-	472,292	472,292	516,851
Bureau of Land Management											
Rangeland	Acres	26,738	-	26,738	-	-	-	155,000	-	155,000	155,000
Technical Assistance		-	-	-	-	-	-	20,000	-	20,000	20,000
BLM Subtotal					-	-	-	175,000	-	175,000	175,000
Forest Service											
Forest and Rangeland	Acres	20,193	-	20,193	-	-	-	43,975	-	43,975	43,975
FS Subtotal					-	-	-	43,975	-	43,975	43,975
Bureau of Indian Affairs											
Cropland	Acres		590	590	-	-	-	-	77,030	77,030	77,030
Rangeland	Acres		9,735	9,735	-	-	-	-	64,652	64,652	64,652
Technical Assistance					-	-	-	-	19,500	19,500	19,500
BIA Subtotal									161,182	161,182	161,182
TOTAL LAND TREATMENT						44,559	44,559	218,975	633,474	852,449	897,008
STRUCTURAL MEASURES											
Construction											
Soil Conservation Service											
Floodwater Retarding Struc.	No.	3	10	13	644,403	1,251,277	1,895,680	-	-	-	1,895,680
Floodwater Diversion - 2	Feet		8,650	8,650	-	59,280	59,280	-	-	-	59,280
Outlet Channel w/appurt. Structures	Feet		2,610	2,610	-	11,788	11,788	-	-	-	11,788
Agricultural Water Management Structures			2	2	-	1,404	1,404	-	1,404	1,404	2,808
Subtotal - Construction					644,403	1,323,749	1,968,152	-	1,404	1,404	1,969,556
Installation Services											
Soil Conservation Service											
Engineering Services					102,216	249,894	352,110	-	-	-	352,110
Other					33,972	71,666	105,638	-	-	-	105,638
Subtotal - Installations					136,188	321,560	457,748	-	-	-	457,748
Other Costs											
Land Easements & R/W								1,695	21,725	23,420	23,420
Administration of Contracts								600	2,400	3,000	3,000
Subtotal - Other								2,295	24,125	26,420	26,420
TOTAL STRUCTURAL MEASURES					780,591	1,645,309	2,425,900	2,295	25,529	27,824	2,453,724
TOTAL PROJECT					780,591	1,689,868	2,470,459	221,270	659,003	880,273	3,350,732
SUMMARY											
Subtotal SCS					780,591	1,689,868	2,470,459	2,295	497,821	500,116	2,970,575
Subtotal BLM								175,000	-	175,000	175,000
Subtotal FS								43,975	-	43,975	43,975
Subtotal BIA									161,182	161,182	161,182
TOTAL PROJECT					780,591	1,689,868	2,470,459	221,270	659,003	880,273	3,350,732

Price base: 1966 construction

June 1968

7
1.1

Table 2, Estimated structure cost distribution, Sebastian Martin-Black Mesa Watershed, Upper Rio Grande Basin, New Mexico (dollars) 1/

Structure site number and name	Public Law 566 installation cost: Constr. engr. est.	Inst. Services: Engineering	Inst. Services: Other	Total Public Law 566	Other installation cost: Construction 2/	Admin. of contr	Easements & R/W	Total other	Estimated total cost
Site 1 (Arroyo Pueblito)	46,805	11,701	2,662	61,168	-	200	150	350	61,518
Site 2 (Arroyo del Guigue)	35,620	8,905	2,026	46,551	-	200	120	320	46,871
Site 3 (Arroyo Rafael)	33,383	8,346	1,899	43,628	-	200	120	320	43,948
Site 4 (Arroyo Borregos)	51,583	12,896	2,934	67,413	-	200	300	500	67,913
Site 5 (Arroyo Lopez)	56,210	14,053	3,197	73,460	-	200	1,080	1,280	74,740
Site 6 (Arroyo Estaca)	91,963	22,991	5,230	120,184	-	200	875	1,075	121,259
Site 7 (Arroyo Lyden)	247,398	37,110	12,945	297,453	-	150	150	300	297,753
Site 15 (Arroyo Ranchitos)	282,439	42,366	14,779	339,584	-	300	4,995	5,295	344,879
Site 16 (Arroyo Chinguague)	228,430	41,117	12,264	281,811	-	200	1,200	1,400	283,211
Site 17 (Arroyo Chavez)	177,446	31,940	9,527	218,913	-	200	840	1,040	219,953
Site 18 (Arroyo Alcalde)	55,554	13,889	3,160	72,603	-	200	700	900	73,503
Site 19 (Arroyo Palacio)	365,767	54,865	19,139	439,771	-	200	500	700	440,471
Site 20 (Arroyo Pueblo)	223,082	33,462	11,673	268,217	-	200	495	695	268,912
Diversion FD-2	59,280	14,820	3,372	77,472	--	300	3,320	3,620	81,092
Outlet Channel 700 & Appurtenant Struc.	11,788	2,947	671	15,406	-	50	8,575	8,625	24,031
Subtotal - Flood prevention	1,966,748	351,408	105,478	2,423,634	-	3,000	23,420	26,420	2,450,054
Site 201	204	102	23	329	204	-	-	204	533
Site 702	1,200	600	137	1,937	1,200	-	-	1,200	3,137
Subtotal - Agricultural Water Management	1,404	702	160	2,266	1,404	-	-	1,404	3,670
GRAND TOTAL	1,968,152	352,110	105,638	2,425,900	1,404	3,000	23,420	27,824	2,453,724

1/ Price base: 1966

2/ Local share of cost allocated to Agricultural Water Management for structures on outlet channel irrigation ditch crossing downstream for sites 2 and 7.

Table 3, Cost allocation and cost sharing summary, Sebastian Martin-Black Mesa Watershed, New Mexico (dollars) 1/

Item	Purpose: Flood prevention	Purpose: Agricultural water management	Total
Single purpose		Cost allocation	
Floodwater retarding structures 1, 2, 3, 4, 5, 6, 7, 15, 16, 17, 18, 19, 20	2,344,931	-	2,344,931
Floodwater Diversion 2	81,092	-	81,092
Outlet channel 700 and appurtenant structures	24,031	-	24,031
Subtotal	2,450,054	-	2,450,054
Drop inlet 201	-	533	533
Drop inlet 702	-	3,137	3,137
Subtotal	-	3,670	3,670
Total	2,450,054	3,670	2,453,724
		Cost sharing	
Public Law 566	2,423,634	2,266	2,425,900
Other	26,420	1,404	27,824
Total	2,450,054	3,670	2,453,724

1/ Price base: 1966 construction cost

Table 4, Structure data, floodwater retarding structures, Sebastian Martin-Black Mesa Watershed

	Unit	STRUCTURE NUMBERS 1	2	3	4	5	6	7	15	16	17	18	19	20	TOTAL
Drainage Area	Sq. Mi	0.56	0.21	0.27	1.40	0.92	1.69	3.65	3.05	4.90	3.31	0.95	10.08	4.00	34.99
Storage Capacity															
Sediment 4/	Ac.Ft.	64	25	33	71	22	52	49	174	230	134	44	400	145	1449
Floodwater	Ac.Ft.	63	20	21	248	153	314	55	831	902	651	161	544	840	4803
Total	Ac.Ft.	127	45	54	319	175	366	104	1005	1132	785	205	950	985	6252
Surface Area															
Sediment Pool	Acre	8	3	3	7	3	8	3	49	29	18	10	40	16	197
Floodwater Pool	Acre	12	5	5	19	10	20	4	115	74	52	25	65	33	439
Volume of Fill	Cu.Yd.	55,085	24,882	27,023	55,691	63,331	128,005	115,812	520,764	390,082	285,824	64,493	365,721	378,164	2,474,877
Elevation Top of Dam	Feet	5802.6	5774.8	5762.0	5773.5	5773.4	5764.7	5851.3	5773.65	5876.5	5876.1	5814.2	5952.8	5959.1	-
Maximum Height Dam	Feet	30.6	27.6	31.0	48.5	56.1	60.8	73.1	29.6	43.5	47.7	30.2	47.7	63.1	-
Emergency Spillway															
Crest Elevation	Feet	5799.0	5771.0	5758.0	5768.0	5766.0	5760.0	5836.2	5770.0	5870.8	5868.0	5809.0	5942.2	5951.5	-
Bottom Width	Feet	200	100	200	200	100	300	100	600	500	400	150	200	250	-
Type		Earth	Earth	Earth	Earth	Earth	Earth	R/C Chute	Earth	Earth	Earth	Earth	R/C Chute	Earth	-
Percent chance of use		3/	3/	3/	3/	3/	3/	4	3/	3/	3/	3/	1	3/	-
Aver. Curve No. Condition II		80	80	80	80	80	80	80	79	80	80	80	80	80	-
Emergency Spillway Hydrograph															
Storm Rainfall (6 Hr.)	Inch	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	-
Storm Runoff	Inch	4.32	4.32	4.32	4.32	4.32	4.32	4.32	4.22	4.32	4.32	4.32	4.32	4.32	-
Velocity of Flow(vc) 1/	F.P.S	2.7	2.0	2.8	3.6	3.8	3.45	12.0	2.5	3.65	1.69	2.45	10.2	neg.	-
Discharge Rate 1/	C.F.S	121	25	153	227	124	380	5367	282	758	60	68	6588	7	-
Max. Water Surface Elevation 1/	Feet	5800.0	5771.4	5758.6	5769.0	5767.0	5761.0	5842.8	5770.4	5872.1	5868.2	5809.8	5945.6	51.6	-
Freeboard Hydrograph															
Storm Rainfall (6 Hr.)	Inch	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	-
Storm Runoff	Inch	14.33	14.33	14.33	14.33	14.33	14.33	14.33	14.18	14.33	14.33	14.33	14.33	14.33	-
Velocity of Flow(vc) 1/	F.P.S.	7.8	7.4	6.6	9.8	11.3	8.3	18.0	7.6	9.5	7.4	8.6	16.6	10.7	-
Discharge Rate 1/	C.F.S	3085	1235	1790	5976	4475	5473	18057	8110	12779	5170	2942	27078	9532	-
Max. Water Surface Elevation 1/	Feet	5802.6	5774.8	5762.0	5773.5	5773.4	5764.7	5851.3	5773.65	5876.5	5876.1	5814.2	5952.8	5959.1	-
Principal Spillway															
Capacity 2/	C.F.S.	100	49	66	93	89	96	126	70	92	91	82	98	85	-
Capacity Equivalents															
Sediment Volume	Inch	2.15	2.25	2.26	0.95	0.50	1.01	0.25	1.07	0.88	0.76	0.87	0.76	0.68	-
Detention Volume	Inch	2.12	1.80	1.44	3.33	3.13	3.49	0.28	5.11	3.45	3.69	3.17	1.01	3.94	-
Spillway Volume	Inch	1.55	2.07	1.51	1.65	1.64	2.21	0.41	1.26	1.74	3.85	3.25	2.23	3.94	-
Class of Structure		c	c	c	c	c	c	c	c	c	c	c	c	c	-

1/ Maximum during passage of hydrograph.
2/ Maximum capacity discharging 1% design flow unless otherwise specified.
3/ Less than 1 percent chance of use.
4/ Erosion rates range up to 5.0 ac. ft./sq.mi./yr, or more, sediment storage rates vary from 0.13 to to 1.19 ac. ft./sq. mi./yr.

June 1968

Table 5, Annual cost, Sebastian Martin-Black Mesa Watershed, Upper Rio Grande Basin, New Mexico (dollars)

Evaluation unit	Amortization of installation cost 1/	Operation and maintenance cost	Total
Floodwater retarding structures			
Site 1 (Pueblito)	2,877	315	3,192
Site 2 and 201 (El Guigue)	2,217	261	2,478
Site 3 (San Rafael)	2,055	353	2,408
Site 4 (Borregos)	3,176	236	3,412
Site 5 (Lopez)	3,495	258	3,753
Site 6 (Estaca)	5,670	253	5,923
Site 7 w/outlet chan. & 702 (Lyden)	15,193	565	15,758
Site 15 & FD 2 (Ranchitos)	19,918	1,320	21,238
Site 16 (Chinguague	13,243	628	3,871
Site 17 (Chaves)	10,285	488	10,773
Site 18 (Alcalde	3,437	255	3,692
Site 19 (Palacio)	20,596	503	21,099
Site 20 (Pueblo)	12,574	613	13,187
Total	114,736	6,048	120,784

1/ 1966 prices amortized at 4 5/8 percent interest for 100 years.
2/ Adjusted normalized prices.

Table 6, Estimated average annual flood damage reduction benefits, Sebastian Martin-Black Mesa Watershed, New Mexico (dollars) 1/

Item	Estimated average annual damages		Damage reduction benefits
	Without project	With project	
Floodwater			
Agricultural			
Crop and pasture	42,061	4,745	37,316
Other agricultural	15,791	3,624	12,167
Non-agricultural			
Roads and bridges	1,433	1,344	89
Residential	849	-	849
Subtotal	60,134	9,713	50,421
Sediment			
Agricultural			
Crop and pasture	53,651	15,093	38,558
Land (loss of productivity)	29,519	3,192	26,327
Other agricultural			
Irrigation Facilities	12,513	2,347	10,166
Non-agriculture			
Road and bridge	1,433	1,344	89
Residential	849	-	849
Subtotal	97,965	21,976	75,989
Indirect	15,953	3,303	12,650
Total	174,052	34,992	139,060

1/ Adjusted normalized prices.

Table 7, Comparison of benefits and costs for structural measures, Sebastian Martin-Black Mesa Watershed, New Mexico (dollars)

Evaluation unit	Average annual benefits 1/					Average annual cost	Benefit-cost ratio
	Flood prevention						
	Damage reduction	Changed land use urban	Redevelopment	Secondary	Total		
Site 1 (Pueblito)	2,948	-	408	268	3,624	3,192	1.1:1
Site 2 & 2o1 (El Guique)	2,651	168	311	258	3,388	2,478	1.4:1
Site 3 (San Rafael)	4,464	-	291	406	5,161	2,408	2.1:1
Site 4 (Borregos)	2,974	-	449	270	3,693	3,412	1.1:1
Site 5 (Lopez)	3,861	-	490	351	4,702	3,753	1.3:1
Site 6 (Estaca)	4,600	-	765	418	5,783	5,923	1.0:1
Site 7 w/outlet chan. & 702 (Lyden with sed. traps)	11,810	-	1,233	1,074	14,117	15,758	.9:1
Site 15 & FD 2 (Ranchitos)	22,025	-	2,596	2,002	26,623	21,238	1.3:1
Site 16 (Chinguague	26,764	-	1,897	2,433	31,094	13,871	2.2:1
Site 17 (Chavez)	9,010	-	1,475	819	11,304	10,773	1.0:1
Site 18 (Alcalde)	14,746	-	484	1,341	16,571	3,692	4.5:1
Site 19 (Palacio)	17,453	-	2,931	1,587	21,971	21,099	1.0:1
Site 20 (Pueblo)	13,731	-	1,854	1,248	16,833	13,187	1.3:1
Total	137,037 2/	168	15,184	12,475	164,864	120,784	1.4:1

1/ Adjusted normalized prices

2/ In addition, it is estimated that land treatment measures will produce flood reduction benefits of $2,783 annually,

Table 8, Land treatment needs, Sebastian Martin-Black Mesa Watershed
Upper Rio Grande Basin, New Mexico

Land treatment system	Total acres	Total treatment completed	Total acres remaining	Total needs
1. Grassland				
1b-Snowpack mgt.				
1c-Good range mgt	10,598	-	-	10,598
2. Grazable woodland				
2a-Pinyon-juniper control	6,850	114	6,736	6,736
2b-Pinyon-juniper mgt.	11,083	-	-	11,083
3. Brushland				
3a1-Greasewood control	528	25	503	503
4. Commercial timber				
4a-Spruce-fir mgt.	3,446	-	3,446	517
4b-Ponderosa pine mgt.	11,341	-	11,341	1,134
5. Bottomland				
5a-Phreatophyte control	1,800	-	1,800	1,800
5b-Bottomland mgt.	200	-	-	200
6. Crop, pasture, hayland				
6a-Irrigated land	7,995			
6a1-Drainage	4,400	-	4,400	4,400
6a2-Improved irrigation	6,150	1,470	4,860	4,860
6b-Dryland				
6c-Abandoned cropland				
7. Miscellaneous land	610			
8. Critical erosion areas	48,589	5,120	43,469	43,469

Table 9, Land treatment needs and impacts (1969-1980), Sebastian Martin-Black Mesa Watershed, Rio Grande Basin, New Mexico

Land treatment system	Needs treatment (acres)	Total treatment cost $	Impacts - average annual values: Water $	Sediment reduction $	Red meat $	Timber wood $	Cultivated land $	Increased net income $	Employment man-years
1. Grassland									
1b-Snowpack mgt.									
1c-Good range mgt.	10,598	5,299		248	4,770			5,018	.4
2. Woodland									
2a-Pinyon-juniper control	6,736	114,512		700	6,066			6,766	8.6
2b-Pinyon-juniper mgt.	11,083	110,830		1,423	6,651			8,074	8.3
3. Brushland									
3a1-Greasewood control	503	6,036		56	1,134			1,190	.4
4. Commercial timber									
4a-Spruce-fir mgt.	517	20,680	1,896	23	576	2,042		4,539	1.6
4b-Ponderosa pine mgt.	1,134	34,020	1,040	56	1,278	4,366		6,740	2.6
5. Bottomland									
5a-Phreatophyte control	1,800	54,000	59,400		16,200			75,600	4.0
5b-Bottomland mgt.	200	2,000			450			450	.1
6. Cultivated									
6a-Irrigated land									
6a1-Drainage	4,400	88,000					330,000	330,000	6.6
6a2-Improved irrig.	4,860	534,600					364,500	364,500	26.6
7. Miscellaneous									
8. Critical erosion area	43,469	652,035		1,953	97,803			99,756	48.9

LEGEND

(symbol)	FLOODWATER RETARD STR.
②	SITE NUMBER
(symbol)	FLOODWATER DIVERSION
(symbol)	DIKES OR LEVEES (EXIST.)
1c	GOOD RANGE MGT.
2a	PINYON-JUNIPER CONTROL
2b	PINYON-JUNIPER MGT.
3-1	GREASEWOOD CONTROL
4a	SPRUCE-FIR MGT.
4b	PONDEROSA PINE MGT.
5	BOTTOMLAND VEGETATION MGT.
6a	IRRIGATED LAND MGT.
8	CRITICAL EROSION AREA

STRUCTURE LOCATION
AND
LAND TREATMENT MAP

SEBASTIAN-MARTIN WATERSHED
UPPER RIO GRANDE BASIN

SCALE 1" = 2 MI.

APPROX. SCALE 1:125,000

1969

Definitions Land Treatment Systems

1. Grassland Management Area - (potential benefits include increased forage production, reduction in sediment yield and increased water yield.)

   1b. Snowpack Management - This treatment system applies to open grasslands at elevations above 10,000 feet. Snowfall is managed by constructing barriers (vertical slat snow fence) of appropriate height and spacing to create drifts, thus reducing evaporation caused by wind action. Bush-type vegetation can be planted to eventually replace the barriers.

   1c. Good Range Management - This treatment system includes the remainder of the open grassland not in 1b or 8. Benefits can be expected by using better than average range management. Treatment includes the proper combination of the following practices: deferred grazing, rotation-deferred grazing, proper grazing use, and better livestock distribution through use of fencing and water locations.

2. Grazable Woodland Management Area - (Potential benefits include increased forage production for livestock and big game, limited wood products, and reduction in sediment yields).

   2a. Pinyon-juniper Control - This treatment system applies to grazable woodland areas with moderately deep and deep soils on moderate slopes. Treatment includes tree and brush removal and the proper combination of practices as shown in 1c or 8 based on the need for either critical area management or good range management and wildlife habitat protection or improvement.

   2b. Ponderosa Pine-Pinyon-Juniper Management - This treatment system applies to the non-commercial ponderosa pine (under 45 site index) and the remaining pinyon-juniper areas. Treatment includes selective thinning and spot clearing of woody vegetation, needed good range management practices as shown in 1c, and wildlife habitat protection and improvement.

3. Brushland Management area - (Potential benefits include increased forage production for livestock and big game and a reduction in sediment yield. An increased water yield may be expected on brushland at high elevations).

   3a. _____brush control - This treatment system applies to all _____brush covered land on topography and soils suited to _____brush clearing methods. Depending upon type of brush treatment may include plowing and seeding, burning and seeding, shredding or spraying or grubbing and stacking of brush followed by the proper combination of practices as shown in 1c or 8 based on the need for critical area management or good range management and wildlife habitat protection or improvement.

3b. _____brush Area Management - This treatment system applies to all brushland on which brush control is unnecessary or undesirable. Treatment includes the proper combination of the following practices: deferred grazing, rotation-deferred grazing, proper grazing use, better livestock distribution through use of fencing and water locations, and wildlife habitat protection or improvement.

4. Commercial Timber Management Area - (Potential benefits include increased water yield, timber harvest, and forage production for livestock and big game.)

4a. Spruce-Fir Management Area - Treatment system applies to all spruce-fir and mixed conifer stands suitable for treatment. Treatment includes the proper combination of the following practices: block and strip cutting for spruce-fir and selective cutting for mixed conifer, thinning, tree planting, fire protection, proper grazing use, and wildlife habitat.

4b. Ponderosa Pine Management - Treatment system applies to all commercial ponderosa pine (over 45 site index) stands suitable for treatment. Treatment includes the proper combination of the following practices: harvest cutting, thinning, pruning, tree planting, seeding grass, proper grazing use, fire protection, and wildlife habitat protection or improvement.

4c. Aspen Management - Treatment system applies to all aspen stands suited to management for regrowth of aspen. Treatment includes the proper combination of practices necessary to provide for proper grazing use and wildlife habitat protection or improvement.

5. Bottomland Vegetation Management Area - (Potential benefits include increased water yield and forage production).

5a. Phreatophyte Control - Treatment system applies to all areas invaded by undesirable woody vegetation. Treatment includes the proper combination of the following practices: clearing, thinning, shredding, spraying, reseeding to adapted grasses, and proper grazing management.

5b. Bottomland Management - Areas on which it is desirable to maintain some woody vegetation cover for recreation, wildlife habitat and aesthetic purposes.

6. Crop, Pasture, and Hayland Management Area - (potential benefits include savings of water, reduction in sediments, and increased crop and forage yields).

6a. Irrigated Land Management - Treatment system applies to all irrigated land. Treatment includes the proper combination of the following practices: conservation cropping systems, pasture and hayland management, timely tillage, irrigation water management, and the following:

6a1. Drainage - practice involves reclamation of land subject to a crop-inhibiting water table.

6a2. Improved Farm Irrigation System - Practices include realigning irrigation canals, laterals, and field ditches, ditch lining, irrigation pipelines, sprinkler systems, land leveling, and tail water recovery facilities.

6b. Dry Land Management - Treatment system applies to all dry crop, pasture, and hay land. Treatment includes the proper combination of the following practices: conservation cropping systems, contour farming, diversion, terraces, proper residue management, pasture and hayland planting or renovation, and pasture and hay land management.

6c. Abandoned Cropland Management - Treatment system applies to all permanently idle land that was previously cropped. Treatment includes the proper combination of the following practices: reseeding with adapted grasses, trees or shrubs, small gully control, water spreading devices, surface roughening, and the needed good range management practices listed in 1c.

7. Miscellaneous Land - Land from which few, if any, economic benefits can be expected from land treatment, Included are inaccessible areas (very steep land) and non-productive land (rockland, riverwash, water areas, badlands, cities, towns, roads, airports, farm sites, and other cultural areas).

8. Critical Erosion Areas - (Potential benefits include - sediment and wind damage reduction and increased forage yields.) This treatment system applies any place where special methods are needed to reduce erosion and to restore the area to productive use. Treatment includes the proper combination of the following practices: livestock exclusion or limited livestock use, small gully control, water-spreading devices, grazing land mechanical treatment, fencing, intensive vegetation management and critical area seeding.

IRRIGATION SYSTEMS IN EL RIO ARRIBA SUBBASIN, UPPER RIO GRANDE BASIN, NEW MEXICO WITH NUMBER OF FARMS SERVED AND ACRES SERVED.

Irrigation ditches in San Pedro Creek Watershed (1-134)

Name of Ditch	Source of water	No. of farms served	No. of acres served	General condition
Cochiti Main Canal	Rio Grande	San Felipe Pueblo	104	
Borrego Watershed (1-135)				
Sili Main Canal	Rio Grande	Cochiti Pueblo	411	
		Santo Domingo Pueblo	1,527	
		San Felipe Pueblo	841	
Arroyo de La Vega Watershed (1-136)				
Cochiti Main Canal	Rio Grande	Santo Domingo Pueblo	1,152	
		San Felipe Pueblo	897	
Arroyo de la Jara (I-137)				
McKee	Galisteo Creek	1	130	Poor
Arroyo San Cristobal Watershed (1-138)				
		No irrigation		
Galisteo Creek Watershed (1-139)				
Cochiti Main Canal	Rio Grande	Cochiti Pueblo	322	
		Santo Domingo Pueblo	932	
Santa Fe River Watershed (1-140)				
Vicinity of Santa Fe	Sewage effluent		10	Poor
Vicinity of Santa Fe Municipal Airport	Sewage effluent		60	Poor
Vicinity of La Bajada			6	Poor
Lower Cienega Creek	Cienega Creek		210	Poor
Cochiti Main Canal	Rio Grande	Cochiti Pueblo	362	

Name of Ditch	Source of water	No. of farms served	No. of acres served	General condition
Bandelier Watershed (1-141)				
Jim Young Ditch	Cochiti Canyon	1	40	Good
Sili Main Canal	Rio Grande	Cochiti Pueblo	434	
Canada Ancha Watershed (1-142)				
Cochiti Main Canal	Rio Grande	Cochiti Pueblo	199	
White Rock Watershed (1-143)				
	No irrigation			
Pojoaque Watershed (1-144 and 1-145)				
Acequia Cajon Grande	Big Tesuque	8	14 3/	Fair
Acequia de la Cruz (Cy Moore)	"	8	16 3/	Fair
Acequia Madre de Tesuque	"	58	80 3/	Poor
Acequia Chiquita	Acequia Madre	9	5 3/	Good
Acequia Medio de Tesuque	Rio Tesuque	98	62 3/	Poor
Miller Ditch	Tesuque Pueblo	Indian Land		Good
Acequia de los Ortizes	Rio Tesuque & Springs	13	35 3/	Fair
Acequia de los Ojitos	Rio Tesuque & Springs	11	23 3/	Poor
Acequia de los Romeros	Rio Tesuque & springs	16	48 3/	Fair
Acequia del Rio	"	10	32 3/	Fair
Acequia del Barranco Blanca	"	14	65 3/	Good
Acequia Larga	Rio Pojoaque & Rio Tesuque	38	160 3/	Poor
Acequia del Jacona	Rio Pojoaque & springs	1	16 3/	Good

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Acequia del Barranco	Rio Pojoaque & springs	35	101 3/	Fair
Adequia de la Otra Vanda	"	37	205 3/	Fair
Acequia El Rancho	"	25	69 3/	Fair
Acequia de los Indios	"	48	172 3/	Fair
Acequia del Alamo	Rio Pojoaque & springs	4	45 3/	Fair
Acequia del Barranco Alto	Rio Nambe	11	94 3/	Good
Acequia de los Trujillo	"	12	81 3/	Fair
Acequia Ancon	Rio Nambe	2	16 3/	Fair
Acequia de las Joyas	"	30	171 3/	Good
Acequia del Rincon	"	46	98 3/	Fair
Acequia del Cano	"	26	190 3/	Fair
Acequia de los Ortiz Nambe	"	43	148 3/	Fair
Acequia de la Communidad de Nambe	"	43	235 3/	Good
Acequia Mocha	Rio Nambe	12	40 3/	Fair
Acequia La Nueva	"	45	175 3/	Fair
Acequia del Llano Frio	"	20	260 3/	Fair
Highline Canal	"	Indian Land		Good
Acequia de Chupadero	Pacheco Creek (Rio Chupadera)	25	111 3/	Good
Acequia Rio Medio	Rio Medio	13	30	Fair
Santa Cruz Watershed (1-146)				
Acequia de la Polvadera (Mesilla)	Santa Cruz River	110	650 4/	Fair
Acequia de los Ortegas	Santa Cruz River	36	260 4/	Fair
Acequia de los Garcias	Santa Cruz River	34	253 4/	Fair
Acequia de los Herreras	Santa Cruz River	15	170 4/	Fair
Acequia de la Lomita	Santa Cruz River	60	180 4/	Fair
Acequia de Sombrillo	Santa Cruz River	22	160 4/	Fair
Acequia de Santa Cruz	Santa Cruz River	32	555 4/	Fair
Acequia del Llano	Off Santa Cruz Ditch	70	496 4/	Fair

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Acequia de los Fresques	Santa Cruz River	32	100 4/	Fair
Acequia de los Quarteles	"	25	68 4/	Fair
Acequia Mestas	"	7	62 4/	Fair
Acequia Martinez Abajo	"	6	38 4/	Fair
Acequia la Puebla	"	51	341 4/	Fair
Acequia Manzanita	"	2	8 4/	Fair
Acequia Martinez Arriba	"	53	129 4/	Fair
Acequia Espinosa	"	40	197 4/	Fair
Acequia Canada Ancha & El Llano	Rio Quemado	157	723	Fair
Acequia del Rancho	Rio Quemado	43	112	Fair
Acequia del Portero	Rio Quemado	37	180	Fair
Acequia del Rio Chiquito	Rio Chiquito	14	12	Fair
Acequia de los Barriales	Rio Medio	6	18 3/	Fair
Acequia de los Quartales	Rio Medio	7	15 3/	Fair
Acequia de los Placita	Rito Frijoles	15	27 3/	Good
Acequia de los Joya (Molino)	Rito Frijoles	9	9 3/	
Otra Banda	Rio Quemado)			
Acequia Los Barriales	")	76	190	Fair
Acequia en Medio	")			
Acequia Otras	")			

Sebastian Martin Watershed (1-149 and 1-150)

Acequia de los Chicos	Rio Grande	23	98	Good
Acequia de Medio	Rio Grande	46	200	Poor
Acequia de los Garcias	Rio Grande	30	90	Fair
Acequia de los Soldados & Isla Luceros	Rio Grande	16	200	Good
Acequia Alcalde	Rio Grande	109	850	Good
San Juan Pueblo	Rio Grande	All Indian		

Name of Ditch	Source of water	No. of Farms served		No. of acres served	General condition
Acequia de Ranchitos	Rio Grande	30		150	Good
Acequia de la Canova	Rio Grande	8		200	Good
Luden Ditch (Bosque)	Rio Grande (direct)	51		300	Good
Acequia de La Estaca	Rio Grande	10		125	Fair
El Guique (San Rafael)	Rio Grande	30		500	Fair
El Pueblito	Rio Grande	12	Indian	250	Fair
Santa Clara Watershed (1-147)					
Santa Clara Main Canal	Rio Grande	12	Indian	250	Good
Santa Clara Ditch	Santa Clara Creek	12		250	Good
Guachapanque	Santa Clara Creek	30		150	Good
Pajarito Ditch	Rio Grande				Good
Espanola-Rio Chama Watershed (1-148 & 1e-2)					
Santa Clara Main Canal	Rio Grande	12	Indian	250	Good
Acequia de Los Vigiles (Martinez)	Rio Grande & Chama	30		800	Poor
Acequia de los Salazares (Guache)	Chama	72		467 2/	Poor
Acequia de San Jose (Duende)	Hernandez	350		626 2/	Poor
Acequia Chamita & San Juan	Chama & Rio Grande	200		684 2/	Fair
Acequia de Chile	Chama	35		280 2/	Poor
Acequia de los Palacios	Chama	4		Not listed on hydrographic survey. May be part of Martinez y Duranes Ditch	
Acequia Martinez y Duranes	Chama	24		498 2/	Fair
Acequia del Rio	Chama	30		372 2/	Fair
Martinez Ditch	Chama	7		139 2/	Fair
Tierra Azul	Chama	20		176 2/	Poor
Acequia La Puente	Chama	6		177 2/	Poor

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Gonzales (Acequia Colorado & Blanca) Jose Pablo Gonzales	Chama	10	516 2/	Fair
Acequia Silvestrez Abeyta	Chama	12	234 2/	Fair
Acequia Barranco	Rito Frijoles	20	107 2/	Fair
Acequia de Abiquiu	Abiquiu Creek	10	38 2/	Fair
Acequia de Frank Gallegos	Rio Oso		25	Fair
Acequia de San Lorenzo	Rio Oso & Springs	6	300	Fair
Acequia de Los Vigiles (2 ditches)	Rio Oso & Springs	3	80	Fair
Acequia de los Rischales	Rio Oso & Springs	5	200	Fair
Acequia de los Jaramillos (Horse Camp)	Rio Oso & Springs	4	200	Fair
de Lopez Y Trujillo	Rio Vallecitos	8	200	Fair
Abeytas	Rio Vallecitos	10	300	Fair
Archuleta & Lopez	Rio Vallecitos	3	160	Fair
Embudo Creek Watershed (1-151)				
4 ditches	Rito Ojo Sarco	15	110	
Acequia del Medio	Embudo Creek	10	117	Fair
Acequia de Apodoca	Embudo Creek	10	106	Fair
Acequia Sancachosa	Embudo Creek	16	61	Fair
Acequia Leandro Martinez	Embudo Creek	3	36	Fair
Duranes Ditch	Embudo Creek	13	36	Fair
La Acequia del Llano	Embudo Creek	68	177	Fair
Acequia de La Plaza	Embudo Creek	58	75	Fair
Acequia los Cienega Junta	Embudo Creek	19	55	Fair
Acequia del Bosque	Embudo Creek		71	Fair
Acequia De Antonio Roybal	Rio Grande	6	40	Poor
Rinconada	Rio Grande	23	143	Poor
Ojo Sarco Diversion	Rio Trampas	80	660	Poor

Name of ditch	Source of water	No. of farms served	No. of acres served	General Condition
Acequia del Llano de San Miguel	Rio Trampas	12	120	Poor
Acequia de Arriba in El Valle	Rio Trampas	22	110	Fair
Acequia de Abajo in El Valle	Rio Trampas	17	85	Poor
Acequia Norte de Las Trampas	Rio Trampas	28	110	Poor
Acequia Sur de Las Trampas	Rio Trampas	26	100	Poor
Acequia del Rio Chiquito	Rio Chiquito	20	298	Poor
Acequia del Llano de La Vegua	Rio Santa Barbara	20	300	Poor
Acequia de Las Jollas de Llano San Juan	Rio Santa Barbara	25	165	Poor
Acequia de la Otra Banda	Rio Santa Barbara	12	125	Poor
Chamisal-Ojito Canal	Rio Santa Barbara	130	778	Fair
Acequia Maria de Llano San Juan	Rio Santa Barbara	194	890	Fair
Acequia de Llano Largo	Rio Santa Barbara	20	150	Poor
Adequia Madre de Santa Barbara	Rio Santa Barbara	130	959	Poor
Acequia Sur de Rodarte	Rio Santa Barbara	25	175	Poor
Acequia del Camino	Rio Santa Barbara	42	158	Poor
Acequia Penasco	Rio Santa Barbara	23	68	Fair
Acequia de Alrieu	Rio Santa Barbara	19	38	Poor
Acequia Madre de Penasco (south)	"	40	323	Poor
Acequia Sur de Rio Lucio	Rio Santa Barbara	30	140	Poor

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Acequia de Medio de Rio Lucio	Rio Santa Barbara	35	165	Poor
Acequia del Norte de Rio Lucio	Rio Santa Barbara	43	166	Poor
Acequia del Medio (Penasco)	Acequia Madre de Penasco & Drain	49	200	Good
South Placita Ditch Abelino Archuleta Ditch Los Mochas Ditch Vadito North Side Ditch Lower Vadito South Side Ditch Lower Vadito North Side Ditch	Rio Pueblo	173	755	Poor
Telephone Canyon E & W Ditches	Telephone Canyon	9	60	Poor

Rinconada Watershed (1-152)

Rinconada	Rio Grande	6	40	Poor

Taos Watershed (1-153)

No irrigation ditches in watershed

Arroyo Grande Watershed (1-154)

Acequia de los Ojos de la Agua Caliente	Ojos (springs) de la Agua Caliente	21	46	Fair
Acequia de la Isla	Rio Grande	6	36	Fair
Aquitas Calientes	Arroyo Grande	23	54	Poor
Acequia de Los Tangues	Unnamed Arroyo	2	50	Poor

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Lower Rio Grande (1-155)				
Short Ditch	Hondo Canyon	1	30	Fair
Byron Witt Ditch	Arroyo del Alamo	1	75	Poor
Ponce de Leon Hot Springs	Ponce de Leon Hot Springs	4	18	Fair
Acequia de Francisco Martinez	Rio Grande del Rancho	90	527	Fair
Acequia del Rio Grande	Rio Grande del Rancho	159	645	Fair
Acequia del Medio Los Rios	Rio Grande del Rancho	10	46	Fair
Acequia Abajo la Loma	Rio Grande del Rancho	20	47	Poor
Jarosa Ditch	Rio Grande del Rancho	21	77	Poor
Acequia en Media	Rio Grande del Rancho	14	60	Poor
Saucito Ditch	Rio Grande del Rancho	16	66	Poor
Acequia Madre de Tio Gervacio	Rio Grande del Rancho	31	110	Poor
Los Cordova Ditch	Rio Grande del Rancho	35	368	Good
Unnamed Ditch	Torres and Cortez Springs	8	100	Fair
Lopez Spring Ditch	Lopez Ditch	1	10	Fair
Los Cordova Ditch #2	Rio Grande del Rancho	8	169	Fair
Acequia Madre del Rio Chiquito	Rio Chiquito	232	820	Fair
Acequia del Monte	Acequia Madre	60	331	Fair
Unnamed Ditch	Tienditas Creek	4	25	Fair
Talpa Reservoir Ditch		1	2	Good
Acequia en Medio Los Rios		15	59	Fair
Acequia Antonio Maria Graham			23	Fair
Acequia Lucero		1	7	Poor
Pueblita			53	Poor

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Petaca Watershed (1-157)				
Carson Irrigation District	Arroyo Aguaje	0	0	Unserviceable reclamation district
Taos Creek (1-156)				
Seco Watershed (1-158)				
Pueblo Park (1-159)				
52 ditches		1141	12,190	In the 52 ditches, diversions and canals range from poor to good.
Olla Creek Watershed (1-160)				
No irrigation in the watershed				
Arroyo Hondo Watershed (1-161)				
Des Montes Community Ditch	Rio Hondo	38	476	Fair
Rebalso Ditch	Rio Hondo		417	
San Antonio Ditch	Rio Hondo	50	162	Poor
Los Prados Ditch	Rio Hondo	10	44	Poor
Vigil #1	Rio Hondo	7	55	Fair
Vigil #2	Rio Hondo	7	22	Poor
Acequia de Ataloya	Rio Hondo	35	299	Fair
Acequia Madre	Rio Hondo	79	529	Poor
Plaza Ditch	Rio Hondo	29	83	Poor
Frieda Lawrence Ditch	Gallana Canyon	1	18	Fair
Hawk Ditch	Lobo Canyon	3	183	Fair
Del Llano	Rio Hondo		169	
Mariposa	Rio Hondo		246	

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
San Cristobal Watershed (1-162)				
Acequia Madre de San Cristobal (3 ditches)	San Cristobal River	40	444	Poor
Mackie Ditch	San Cristobal River	1	2	Poor
Red River Watershed (1-163)				
Reyes Martinez Ditch	Rito de la Lama	1	6	Fair
La Lama Community Ditch	Rito de la Lama	35	100	Poor
Abad Medina Ditch	Rito de la Lama	1	12	Fair
Acequia Madre	Red River & Cabresto Creek	68	660	Fair
Unnamed Ditch	Cabresto Creek	1	5	Fair
Llano Irrigation Company	Cabresto Creek	33	2,900	Fair
Acequia de Llano	Cabresto Creek	242	800	Fair, Cabresto Irrigation Corporation
Town Ditch	Cabresto Creek			
Mountain Ditch	Cabresto Creek			
Latir Creek Watershed (1-164)				
Hawk Ditch	Rio Primero	1	12	Fair
Gomez Ditch	Rio Primero	2	20	Fair
Gomez Ditch	Rio Primero	1	35	Fair
J. F. Quintana Ditch	Rio Medio	1	90	Fair
Felix Quintana Ditch	Rio Medio	1	20	Fair
Rufus Garcia Ditch	Rio Medio	1	8	Fair
Don Garcia Ditch	Rio Medio	1	15	Fair
E. L. Kennedy Ditch	Rio Medio	1	10	Fair
Quintana Ditch	Jarosito Creek	2	42	Fair
Cerro Community Ditch	Latir Creek	99	1,600	Fair
Latir Ditch	Latir Creek	7	290	Fair

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
No Agua Watershed (1-165)				
No irrigated areas or irrigation systems in this watershed				
Sunshine Valley Watershed (1-166)				
No community ditch systems in this watershed				
Costilla Creek Watershed (1-167)				
J. T. Trujillo No. 1 3/	Costilla Creek	1	16	Poor
J. T. Trujillo No. 2 3/	Costilla Creek	1	8	Poor
Vallejos-Martinez No. 4	Costilla Creek	2	53	Fair
Alberto Maes 3/	Arroyo	1	17	Fair
Emilio Sanchez 3/	Arroyo	1	14	Poor
Antonio de Herrera No. 2	Arroyo	3	11	Poor
Antonio de Herrera No. 1 3/	Arroyo	1	16	Fair
Old Mill Ditch 3/	Costilla	1	10	Poor
J. N. Vallejos No. 1	Costilla	4	13	Fair
Archuleta	Rito Vallejos	2	1	Poor
Vallejos Martinez No. 3	Rito Vallejos	2	7	Fair
Vallejos Martinez No. 2	Rito Vallejos	2	3	Fair
Arroyo Ditch	Arroyo	2	2	Poor
Vallejos Martinez No. 1	Costilla	3	51	Poor
David Martinez	Costilla	2	10	Poor
J. M. Lobato	Costilla	3	8	Poor
J. J. Santistevan 1/	Costilla	36	220	Fair
Lado Norte	Costilla	6	72	Fair
Francisco Sanchez No. 3	Rito Sanchez	2	4	Poor
Florentino Gallegos No. 2 3/	Rito Sanchez	1	2	Fair
Francisco Sanchez No. 2 3/	Rito Sanchez	1	6	Fair

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Francisco Sanches No. 1	Rito Sanchez	2	2	Fair
Florentino Gallegos No. 1 3/	Rito Sanchez	1	1	Fair
J. Archuleta y Rael No. 2	Rito Sanchez	2	1	Poor
J. Archuleta y Rael No. 1 3/	Rito Sanchez	1	7	Poor
J. M. Barela	Costilla	4	16	Poor
Jose Cleofas Arellano	Costilla	4	16	Fair
Teodoro Martinez 3/	Ute Creek	1	4	Poor
Jose Angel Martinez No. 1 3/	Ute Creek	1	40	Poor
J. A. Martinez No. 2 3/	Rito de la Plaza	1	1	Poor
Dicnicio Lucero	Rito de la Plaza	3	6	Poor
Arcadio Lucero No. 2	Rito de la Plaza	5	21	Fair
J. A. Gonzales	Rito de la Plaza	4	4	Poor
Arcadio Lucero No. 1	Rito de la Plaza	8	40	Poor
Acequia de Los Madriles	Rito de la Plaza	9	114	Fair
Jose Maria Meira	Rito de la Plaza	14	120	Fair
A. J. Arellano No. 2	Costilla	2	46	Poor
A. J. Arellano No. 1	Costilla	2	18	Poor
Vicente Gonzales	Costilla	1	3	Poor
S. A. Valdez 3/	Costilla	1	22	Poor
P. Y. Barela No. 1 3/	Costilla	1	14	Poor
P. Y. Barela No. 2 3/	Costilla	1	1	Poor
Jessie Grubb No. 1 3/	Costilla	1	4	Poor
Jessie Grubb No. 2 3/	Costilla	1	2	Poor
Acequia Madre	Costilla	21	1,100	Good
Carro Canal (Manzanares)	Costilla	30	80	Good
Penasquito	Costilla	20	112	Fair
Plaza de Arriba	Costilla	40	400	Fair
Plaza del Medio	Costilla	45	280	Poor
M. E. Trujillo	Costilla	5	25	Fair
A. J. Arellano & Sons	Costilla	40	286	Fair
J. M. Alires	Costilla	2	2	Fair
Acequia del Cerrito	Costilla		305	

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Acequia Narciso Sandoval	Costilla		14	
Acequia de Natifidad Barela de Sisneros No. 1			6	
No. 2			4	
Vigil No. 1, 2, 3, 4, & 5			19	
Los Pinos Watershed (Colo. 1b-1)				
Eight unnamed ditches	Rio de Los Pinos	90	315	Poor
Rio San Antonio Watershed (Colo. 1b-2)				
Four Unnamed Ditches	San Antonio River	10	100	Fair
Watershed (Colo. 1-17)				
No irrigated area or ditches in watershed				
El Rito Watershed (1c-1, 1c-6, and 1c-7)				
Del Vadito	El Rito Creek	3	25	
Madre de la Jara de Medio de la Plaza del Monte del Comino de los Duranes de Las Alires Otra Banda	El Rito Creek	210	1,650	Fair

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Servietta Plaza and Vallecitos Watersheds (lc-3 and lc-4)				
De La Mesa Pieta	Rio Ojo Caliente	12	117 4/	Fair
del Gavalin	Rio Ojo Caliente	22	265 4/	Fair
de Los Duranes	Rio Ojo Caliente	18	152 4/	Fair
del Ojo	Rio Ojo Caliente	50	206 4/	Fair
de los Luceros	Rio Vallecitos	4	56 4/	Fair
de la Cueva	Rio Vallecitos	10	51 4/	Fair
de la Madera	Rio Vallecitos	14	36 4/	Fair
del Llanito	Rio Vallecitos	16	47 4/	Fair
de los Jaquez	Rio Vallecitos	3	10 4/	Fair
de los Ancones	Rio Vallecitos	6	40 4/	Fair
Otra Banda	Rio Vallecitos	7	15 4/	Fair
De Los Olguines (3 ditches)	Rio Vallecitos	10	39 4/	Fair
Trujillos (3 ditches)	Rio Vallecitos	4	54 4/	Fair
De Vallecitos (3 ditches)	"	36	362 4/	Fair
La Cienega West & La Cienega Atascosa (2 ditches)	Rio Vallecitos	5	47 4/	Fair
La Cienega East	Rio Vallecitos	5	16 4/	Fair
Acequia de Chacones y Associados	Rio Vallecitos	40	123 4/	Fair
Alduces	Rio Vallecitos	6	16 4/	Fair
Pedro Martinez Alphonso Chacon	Rio Vallecitos	2	14 4/	Fair
Tusas Watershed (lc-5)				
11 ditches	Rio Tusas	80	2,400	Note: Hydrographic survey shows 75 ditches, 1800 acres total. 4/

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Canones Creek Watershed (1c-8)				
de Polvadera 2 ditches)	Polvadera Creek	5	150	Fair
2 ditches) 9 ditches	Canones Creek	30	250	Fair
Arroyo Seco Canjilon Watershed (1c-9)				
Acequia de La Otra Borda	Rio de Canjilon	20	100	Good
Del Dordo	Rio de Canjilon	40	1,000	Fair
Del Llano	Rio de Canjilon	70	1,020	Fair
Puerco Watershed (1c-10)				
Encino Ditch	Rito Encinos & springs	15	144 1/	Poor
Felix Garcia	Arroyo de Los Cedras		14 1/	
Lower Puerco	Rio Puerco	9	126 1/	Fair
Madrid Ditch	Rio Puerco	9	94 1/	Poor
Coyote Canal	Coyote Creek	25	175 1/	Fair
Rito de las Sillas	Rio de las Sillas	5	24 1/	Poor
Arroyo de Agua	Rio Puerco	40	98 1/	Fair
Acequia Mesa del Medio	Rito Poleo	20	430 1/	
La Mesa de Pino Vital	Rito Poleo	4	204 1/	
Rio Cebolla Watershed (1c-11)				
Del Pineatal	Rio Cebolla	13	150	Fair
Del Rincon Blanco	Rio Cebolla	12	140	Fair
Del Leandro Montoya	Rio Cebolla	10	40	Fair
De Pedro Trujillo y Chacon	Rio Cebolla	5	60	Fair
Acequia del Reno	El Reno Canyon	22	1,000	Poor

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
Rio Nutrias Watershed (1c-14)				
4 ditches	Rio Nutrias	15	800	Poor
Rio Tierra Amarilla Watershed (1c-16)				
Ensenada Ditch)	Rio Brazos	150	1,116	Fair
El Porviner)				
Parkview Ditch)	Rio Brazos	300	2,100	
La Puente Ditch)				
Tierra Amarilla Ditch	Rito de Tierra-Amarilla	250	750	
Rutherton Ditch	Rio Chama	35	800	
Placito Blanco Ditch	Rio Chama	30	750	
Brazos Watershed (1c-18)				
Los Brazos Ditch	Rio Brazos)	110	1,500	
Los Chavez Ditch	Chavez Creek)			
Rio Chama Watershed (1c-19)				
Lower Canones Ditch	Canones Creek	20	2,000	
Upper Canones Ditch	Canones Creek	3	150	
Hollenbeck Ditch	Rio Chama	5	100	
M & B Ditch	Rio Chama & Rio Chamita	35	1,000	
Zia Pueblo Watershed (1d-1)				
Zia Northside	Rio Jemez	Zia Pueblo	523	
Zia Southside	Rio Jemez	Zia Pueblo	967	
Zia Southside Extension	Rio Jemea	Zia Pueblo	845	
Zia Southside Extension	Rio Jemez	Santa Ana Pueblo	1,881	
Rio Salado Watershed (1d-2)				
No irrigation in this watershed				

Name of ditch	Source of water	No. of farms served	No. of acres served	General condition
San Diego Canyon Watershed (1d-3)				
Abousleman-Hofheins	San Antonio Creek	2	65	Poor
Westside Ditch	Jemez Creek	5	21	Fair
Jemez Springs Community Ditch	Jemez Creek	30	53	Good
Sandoval	Jemez Creek	2	12	Poor
G. Trujillo	Guadalupe Creek	3	20	Poor
Canones Community Ditch	Guadalupe Creek	35	260	Good
Lower Canones Community Ditch	Jemez Creek	3	10	Fair
Jemez Westside	Jemez Creek	Jemez Pueblo	1,180	
San Ysidro Community Ditch	Jemez Creek	60	1,031	Good
(This canal all concrete-lined with adequate control structures)				
San Juan Canyon Watershed (1d-4)				
Jemez Eastside	Jemez Creek	Jemez Pueblo	925	
Zia Main Canal	Zia Pueblo	Jemez Pueblo	97	
Ponderosa Community Ditch	Palize Creek	59	361	Poor
Rio de Las Vacas Watershed (1d-5)				
No irrigation in this watershed				

1/ Acreages decreed by court - 1962
2/ Acreages by interlocutory decrees of the court - 1963-1967.
3/ Acreages presented to the court for adjudication of water rights - 1967.
4/ Acreages determined by hydrographic survey - 1967.

Table of population and population projections of communities greater than 100 people, El Rio Arriba Subbasin, Upper Rio Grande Basin, New Mexico

Community	1965	Increase 1965 to 1970	1970	Increase 1970 to 1980	1980	Increase 1980 to 1990	1990	Increase 1990 to 2000	2000	Increase 2000 to 2010	2010	Increase 2010 to 2020	2020
Abiquiu	500	-21	479	95	574	218	792	149	941	289	1,230	292	1,522
Alcalde	300	-12	288	57	345	131	476	89	565	173	738	175	913
Arroyo Hondo	250	21	271	90	361	102	463	89	552	96	648	122	770
Arroyo Seco	500	42	542	180	722	204	926	178	1,104	192	1,296	245	1,541
Canjilon	600	-25	575	114	689	262	951	179	1,130	347	1,477	350	1,827
Cerrilos	135	20	155	63	218	106	324	149	473	146	619	142	761
Cerro	220	18	238	79	317	89	406	78	484	84	568	107	675
Chama	2,000	-82	1,918	380	2,298	873	3,171	596	3,767	1,156	4,923	1,167	6,090
Chamisal	500	42	542	180	722	204	926	178	1,104	192	1,296	245	1,541
Cochiti Pueblo	350	7	357	92	449	137	586	53	639	234	873	357	1,230
Cordova	500	-21	479	95	574	218	792	149	941	289	1,230	292	1,522
Costilla	300	25	325	108	433	122	555	107	662	115	777	147	924
Coyote	150	- 6	144	29	173	66	239	21	260	80	340	81	421
Dixon	650	27	677	134	811	308	1,119	210	1,329	408	1,737	412	2,149
El Rito	950	39	989	196	1,185	450	1,635	307	1,942	596	2,538	602	3,140
Espanola	5,000	205	5,205	1,031	6,236	2,370	8,606	18	10,224	3,139	13,363	3,167	16,530
Jemez Pueblo	1,000	21	1,021	262	1,283	392	1,675	152	1,827	669	2,496	1,021	3,517
Jemez Springs	400	8	408	105	513	157	670	61	731	268	999	409	1,408
La Madera	225	- 9	216	43	259	98	357	67	424	130	554	131	685
Llano Quemado	400	33	433	144	577	163	740	142	882	153	1,035	196	1,231
Los Alamos	14,815	6,059	20,874	2,686	23,560	5,489	29,049	9,150	38,199	11,956	50,155	12,489	62,644
Ojo Caliente	450	37	487	162	649	183	832	160	992	172	1,164	220	1,384
Pajarito Acres				(included with Los Alamos)									
Parkview	250	-10	240	48	288	109	397	75	472	145	617	146	763
Pena Blanca	400	8	408	105	513	157	670	61	731	268	999	409	1,408
Penasco	800	66	866	288	1,154	325	1,479	284	1,763	307	2,070	391	2,461
Pojoaque	862	129	991	401	1,392	678	2,070	913	2,983	922	3,905	894	4,799
Questa	1,500	125	1,625	541	2,166	611	2,777	533	3,310	576	3,886	734	4,620
Ranchos de Taos	800	66	866	288	1,154	325	1,479	284	1,763	307	2,070	391	2,461
Red River	4,000	332	4,332	1,443	5,775	629	6,404	1,230	7,634	328	7,962	1,505	9,467
San Ildefonso Pueblo	270	41	311	126	437	213	650	289	939	290	1,229	281	1,510
San Felipe Pueblo	1,200	25	1,225	315	1,540	471	2,011	183	2,194	803	2,997	1,226	4,223
San Juan Pueblo	800	-33	767	152	919	349	1,268	238	1,506	462	1,968	466	2,434
Santa Cruz	500	75	575	232	807	393	1,200	553	1,753	542	2,295	526	2,821
Santa Fe	40,000	6,000	46,000	18,630	64,630	31,475	96,105	44,304	140,409	43,386	183,795	42,089	225,884
Santo Domingo	1,938	41	1,979	509	2,488	853	3,341	179	3,520	1,288	4,808	1,966	6,774
Talpa	600	50	650	216	866	244	1,110	213	1,323	230	1,553	294	1,847
Taos	3,000	249	3,249	1,082	4,331	1,221	5,552	1,066	6,618	1,152	7,770	1,469	9,239
Taos Pueblo	1,300	108	1,408	469	1,877	529	2,406	462	2,868	499	3,367	636	4,003
Tesuque	1,000	150	1,150	466	1,616	787	2,403	1,108	3,511	1,085	4,596	1,052	5,648
Tesuque Pueblo	125	19	144	58	202	98	300	138	438	135	573	131	704
Tierra Amarilla	500	-21	479	95	574	218	792	149	941	289	1,230	292	1,522
Tres Piedras	200	17	217	72	289	81	370	71	441	77	518	98	616
Truchas	690	-28	662	131	793	301	1,094	206	1,300	399	1,699	403	2,102
Vadito	220	18	238	79	317	89	406	78	484	84	568	107	675
Vallecitos	250	-10	240	48	288	109	397	75	472	145	617	146	763
Velarde	250	-10	240	48	288	109	397	75	472	145	617	146	763
White Rock			(Included with Los Alamos)										
Youngsville	200	- 8	192	38	230	87	317	60	377	116	493	117	610
Zia Pueblo	395	8	403	104	507	155	662	60	722	264	986	403	1,389
Sub Total	92,245	13,835	106,080	32,309	138,389	52,958	191,347	66,769	258,116	75,128	333,244	78,687	411,931
Rural in County													
Rio Arriba	6,597	-270	6,327	1,253	7,580	2,880	10,460	1,966	12,426	3,815	16,241	3,849	20,090
Taos	2,227	185	2,412	803	3,215	907	4,122	791	4,913	855	5,768	1,090	6,858
Santa Fe	8,843	1,326	10,169	4,118	14,287	6,958	21,245	9,794	31,039	9,591	40,630	9,304	49,934
Sandoval	2,947	61	3,008	773	3,781	1,157	4,938	449	5,387	1,972	7,359	3,010	10,369
Los Alamos	3,535	1,449	4,984	2,313	7,297	1,700	8,997	2,834	11,831	3,703	15,534	3,868	19,402
Sub Total	24,149	2,751	26,900	9,260	36,160	13,602	49,762	15,834	65,596	19,936	85,532	21,121	106,653
Total	116,394	16,586	132,980	41,569	174,549	66,560	241,109	82,603	323,712	95,064	418,776	99,808	518,584

Table of population, El Rio Arriba Subbasin, Upper Rio Grande Basin, New Mexico

Year	Population increase			Total population in basin		
	Cities greater than 100	Communities less than 100 & rural	Total	Cities greater than 100	Communities less than 100 & rural	Total
1965	-	-		92,245	24,149	116,394
1970	13,835	2,751	16,586	106,080	26,900	132,980
1980	32,309	9,260	41,569	138,389	36,160	174,549
1990	52,958	13,602	66,560	191,347	49,762	241,109
2000	66,769	15,834	82,603	258,116	65,596	323,712
2010	75,128	19,936	95,064	333,244	85,532	418,776
2020	78,687	21,121	99,808	411,931	106,653	518,584

Table of water needs and consumptive use - power, El Rio Arriba Subbasin, Upper Rio Grande Basin, New Mexico

Year	Municipal and rural domestic water needs (gallons/day)	Municipal and rural domestic water consumptive use (gal./day)	*Relationship of rural domestic and municipal water needs to power water needs	*Relationship of rural domestic and municipal water consumptive use to power consumptive use.	Projected power water needs (gallons/day)	Projected power water consumptive use (gal./day
1965	13,869,164	7,180,905	3.239	0.118	44,922,222	847,347
1970	17,868,070	9,908,710	3.946**	0.139**	70,507,404	1,377,311
1980	28,391,000	17,388,831	5.359	0.177	152,147,369	3,077,823

Table of water needs and consumptive use - industrial

Year	Municipal and rural domestic water needs (gallons/day)	Municipal and rural domestic water consumptive use (gal./day)	*Relationship of rural domestic and municipal water needs to industrial water needs	*Relationship of rural domestic and municipal water consumptive use to industrial consumptive use.	Projected industrial water needs (gal./day)	Projected industrial water consumptive use (gal./day)
1965	13,869,164	7,180,905	1.778	0.547	24,650,374	3,927,955
1970	17,868,070	9,908,710	1.879**	0.530**	33,574,104	5,251,616
1980	28,391,000	17,388,831	2.080	0.495	59,053,280	8,607,471

*Computed factors from pages 1-8, "The Nations Water Resources Summary Report", United States Water Resources Council - 1968.

**Extrapolated factors

Table of water and sewage needs, El Rio Arriba Subbasin, Upper Rio Grande Basin, New Mexico (dollars)

	1970	1980	1990	2000	2010	2020
Total water and sewage needs (new and expanded)	16,881,344	14,632,288	23,429,120	29,076,256	33,462,528	35,132,416
Water and sewage needs - communities greater than 100 population	15,912,992	11,372,708	18,641,216	23,502,688	26,445,056	27,697,824
Water and sewage needs - communities less than 100 and rural	968,352	3,259,520	4,787,904	5,573,568	7,017,472	7,434,592
Federal cost-share potential FHA under PL 660, up to 30%	4,080,559	899,606	1,240,166	992,745	1,601,635	1,455,485
State of New Mexico cost share up to $12,000 per community	516,000					
Total cost to local people for their share of water and sewage development	12,283,685	13,732,682	22,188,954	28,083,511	31,860,893	33,676,931
Total cost to people of community greater than 100 population	11,315,333	10,473,162	17,401,050	22,509,943	24,843,421	26,242,339
Total cost to people of less than 100 community and rural domestic	968,352	3,259,500	4,787,904	5,573,568	7,017,472	7,434,592

Santa Cruz River Watershed (1-146)

This watershed was among the early watersheds planned and built in New Mexico under Public Law 566. The watershed covers an area of approximately 183.1 square miles (117,184 acres) in northeastern Santa Fe, southeastern Rio Arriba, and northwestern Mora Counties. A work plan was completed for the watershed in 1959 which set forth $69,946 for land treatment (local share of $22,300 and $47,646 spent on National Forest and Bureau of Land Management lands). There were proposed six floodwater structures having an aggregate capacity of 1,702 acre-feet for floodwater and sediment storage, 1,143 feet of floodwater diversion, and 3 debris basins. The total planned cost of these structures was $452,277 of which the local share was $1,725 (rights-of-way cost of $525 and contract administration $1,200), and $450,552 Public Law 566 cost.

The project was built in fiscal years 1961 and 1962 with a total construction cost of $332,717.30. Since construction, much damage and probable loss of life has been averted. However, inasmuch as this was one of the first projects built on soils of the Santa Fe Formation, experience has shown that sediment storage capacities were underdesigned for three of the structures (sites 2, 3, and 6). In September 1969, a one percent chance storm occurred above sites 2 and 3 with the result that all sediment and much floodwater storage capacity of sites 2 and 3 was occupied by sediment. The floodwater flow was enough to cause the emergency spillways to flow. It is judged that, even though the structures have lost much of their effectiveness, much damage and possible loss of life was averted. The current approach to the problem is to treat site 3 as an emergency and to appraise the remainder of the watershed as to the possibility of re-opening the project. If the project is re-opened, it appears from preliminary observation that development in the valley during the past 10 years might justify an additional 5 or 6 sites.